Fachhochschule Dortmund
University of Applied Sciences and Arts

International Research Conference 2016

CONFERENCE PROCEEDINGS – 24-25 June 2016

- International Forum for Researchers, Master and PhD students
- Colleagues from different Faculties and Partner Universities
- Presentation and Discussion of Trends and Research Results
- Several Modules contributing to Project Management

International Research Conference in Dortmund 2016

The International Research Conference at the Dortmund University of Applied Sciences and Arts took place on June 24-25 for the sixth time.

The complete series of conferences is documented and results are available as a wikispace http://internationalresearchdortmund.wikispaces.com/ .

The conference was initiated by the community of the European Master in Project Management – EuroMPM. It is our main tool for giving our master students, our PhD students and our partners from Bilbao, Leuven, Kaunas, Trondheim, Kiev, Ternopil, the Netherlands, France, Latvia, Pakistan, Palestine, Bochum, Dortmund and many more countries a forum for meeting, presenting new results and thoughts, and discussing future research and cooperation. The conference was supported by the DAAD Strategic Partnership "European Partnership for Project and Innovation Management (EuroPIM)" which we set up based on the EuroMPM with our partners in Bilbao, Kaunas, Leuven and Trondheim. Furthermore, the Ruhr Master School (established by the Universities of Applied Sciences in Dortmund, Bochum and Gelsenkirchen and funded by Stiftung Mercator) supported the conference. The conference has become the central event of our partnership and an attractive meeting point in the middle of the academic year.

The scope of the conference covered a wide range of topics. A key issue for future projects is the sustainability in all its facets. Sustainability was therefore the common ground for many contributions and a continuous topic in the discussions. It was considered to be the underlying principle in project management, in economics and business, and in technology. The EuroMPM community will focus its research for the coming years on this topic and expects to generate more interesting contributions for future conferences. The special quality of the research is the transdisciplinary and applied character. Many contributions show results from cooperation with industry and society.

This conference has its own spirit and power since the beginning in 2010.

A special thank you goes to the organizing team, headed by Lena Telgmann, Ala Nuseibah and Christian Reimann, and all the active and supportive members of the team.

For the second time, the conference was followed by a summer school in Dortmund, starting on June 27th and ending at July 1st. The summer school was taking some of the topics of the conference and developed them further into new results and new teaching modules. The summer school was organized into the following 5 streams:

- Sustainability in Project Management (Chair: Jose Ramon Otegi)
- General Project Management (Chair: Ruta Ciutene, Asta Daunorienė)
- Usability Engineering (Chair: Christian Reimann)
- Automotive Software Engineering (Chair: Carsten Wolff)
- Case Study Workshop: Writing Cases and Teaching with Cases (Chair: Jan-Philipp Büchler)

In 2016 the conference had 8 sessions, covered on two days:

Session on Sustainable Project Management (Wolfgang Tysiak, Peter Reusch)

- Philosophical Paradigms in Sustainable Project Management Research, Maria Aguilar-Fernández, José Ramón Otegi-Olaso, Leticia Fuentes-Ardeo
- Reporting in Projects – Key to Success, Werner Wetekamp
- The Appearance of Stewardship Theory Model in the Family Business, Éva Málovic
- Managing Successful Project Driving by Entrepreneurship Energy, Sergey Bushuyev, Denis Bushuiev, Ruslan Jaroshenko
- Embedding Antifragility in Projects, José Ramón Otegi-Olaso

Session on Education & Competences (Peter Arras)

- A New Approach on Blended Learning Instructional Design: The Case of Blendlee, Marcos Welker, Jolita Kiznyte, André Dechange
- Interactive Solutions for Competency Management, Olga Mikhieieva
- Aspects of Higher Education Collaborative Projects in Palestine, Suhail Barakeh, Ala Nuseibah
- Ruhr Master School of Applied Engineering – Towards a New Way of Master Education, Rebecca Hegemann-Rockel

Session on Technology Project Management (Galina Tabunshchyk)

- Effectively Developing Medical Software: Basic Considerations, Alexandru Sereseanu, Sascha Richter
- How Agile Procedures Could Support the Mechatronical Development, Nadine Sticherling
- The Need for Situational Leadership in Managing Complex Projects, Syed Shah
- Developing of Self-Configuring Systems: A Case Study, Fabian Kneer, Erik Kamsties

Session 1 on Methods & Tools in Project Management (José Ramón Otegi-Olaso)

- Methods of Project Management in Public Projects in Latvia, Silvija Bruna
- Beyond Agile – Highly Adaptive Project Organizations (H.A.P.) – Stephanie Borgert
- Project Management Competencies, Ian Bloys
- Getting Contract Using Psychological Approaches, Maksym Snahovskyi, Mariia Snahovska
- Initial Steps from Critical Field to Critical Chain, Wolfgang Tysiak

Session on International Project Management (Nerea Toledo Gandarias)

- Business Culture as a Source of Comedy: The Office (UK), Henri de Jongste
- Challenges of RTD Projects, Ala Nuseibah
- Measurement of Efficiency of International Multinational Projects, Peter Arras, Dirk Van Merode, Galina Tabunshchyk

Session on Technology (Carsten Wolff)

- Complexity Reduction via Hierarchical Product Structures in the Field of Automotive Demand and Capacity Management, Daniel Fruhner, Katja Klingebiel, Konrad Pawlikowski, Michael Toth , Axel Wagenitz

- Supporting Pen-and-Paper Role-Play Using Android and Augmented Gaming Materials, Manuel Fried, Sebastian Kaupe, Christian Reimann, Konstantin Koll
- Acoustic-Coupled Communications Systems With Modern Web-Browser APIs, Ulf Müller-Baumgart, Tim Zebulla, Christian Reimann
- Open Edge Computing - From Vision to Reality, Rolf Schuster
- Systems Engineering for Metropolitan Mobility and Energy – RuhrValley, Lena Telgmann, Carsten Wolff

Session on Projectized Organizations (André Dechange)

- Presentation of the Journal: Project Management Research and Practice, Beverly Pasian
- Improved Model of a Financial Sustainability in Organizations, Serhiy Hutsal, Anatoliy Sachenko
- Analyzing Motivation Pattern of Employees, A New Practice to Optimize Organizational Project Management Maturity, Arash Koochakan
- Enterprise Project Management Office (EPMO) for Project Management Efficiency – A Methodology to Achieve European Electricity Production Target by 2030, Ekomenzoge Metuge
- Influence of Organization Strengths on Project Management Competencies and Project Success, Rao Aamir Khan

Session 2 on Methods & Tools in Project Management(Sergey Bushuyev)

- Portfolio Management of Medical Institutions, Elena Danchenko, Vladlen Lepsky
- Project Sustainable Knowledge Acquisition and Exchange through Action Research, Leticia Fuentes-Ardeo, José Ramón Otegi-Olaso, Maria Eugenia Aguilar-Fernandez
- The Construction of Research Questions in Sustainable Project Management, Naiara Briongos
- Mixed Methods Used in Sustainable Project Management, Laura Martínez
- Explorative Project Management for Innovative Projects, Maria Zadnepryanets

We say thank you to all authors for the contributions to the International Research Conference in Dortmund 2016. The contributions are important – as well as the discussions – for the evolution of the community and the growing power to meet the requirements of the future.

Greetings from the flow of strong projects

Peter Reusch and Carsten Wolff

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Philosophical paradigms in Sustainable Project Management Research

Ma. Eugenia Aguilar-Fernández, José Ramón Otegi-Olaso Leticia Fuentes-Ardeo

maguilar003@ikasle.ehu.eus
University of the Basque Country
Department of Engineering Projects and Graphical Expression
Alameda Urquijo, s/n. 48013 - Bilbao (Bizkaia) Spain

Keywords: sustainable project management, philosophical stances, paradigms, methodology

Abstract:

The motivation of this research is to understand how the knowledge regarding to the integration of sustainability is being created by the project management scientific community.
The integration of Sustainability in Project Management Research is still immature compared with other schools of thought but during the last five years and some emergent theories have been identified.

This paper goes one step further to the previous analysis of Pasian and Silvius (2015), Biedenbach and Muller (2011), Smyth and Morris (2007), in order to identify the philosophical stances adopted by the researchers in their studies and the directions taken by the next years.

The methodology was built upon the work of Muller (2011), Smyth (2007) and The sample frame technique is a non-probabilistic, judgment criteria purposed by Malhotra (2008, p 340).

Three sample frames were chosen:

1. A set compound by the main four Project Management Journals: IJPM, JPM, IJMPB, IJPOM
2. A set compound by journals in allied areas following the criteria of Kwak and Anbari (2009).
3. A set compound by the Sustainability and Environmental Journals listed in the JCR database.

It was necessary to conduct a bibliometric research using SCOPUS and WOS (Otegi et al., 2015), using the following keywords:

1. "Project management" + methodology (for the 5 main papers)
2. "Project management" + sustain*
3. "Project management" OR projects + sustain*
4. "Project management" + environ*
5. "Project management" OR projects + environ*

The output of the first set was a set of 10 papers and 5 were selected after reading the abstract and introduction.
The output of the (2-5) points was a set of 51 papers and 25 were selected, after the analysis of the abstracts, and the introduction.

The content examination of the article was based on the criteria of the above mentioned authors, and then a quantitative as well as a qualitative analysis was performed.

The results show a dominance of ontological subjectivism, epistemological interpretivism, the creation of theories through multiple case studies and the increasing use of mixed method. At

the same time, most the authors are still reluctant to describe explicitly their philosophical stances and just apply the methods without an analysis of the alternatives they have to approach the object of study.

The article ends with a reflection about the Sustainability as an emerging school of thought proposed and actively promoted by the research community though the last three years.

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Reporting in Projects – key to success

Prof. Dr. Werner Wetekamp

werner.wetekamp@fh-dortmund.de
University of Applied Sciences and Arts, Dortmund

Keywords: Reporting, Cockpit, Controlling, Project Management

1. Introduction

On the one hand we have a lot of data in projects like thousands of invoices, information about time and schedules, place and usage of resources, achievements in the projects, lists of tasks or just the requirements of the internal or external client. On the other hand we need to be successful in projects and we have to steer and counter steer all items in a project like we have to steer a car to the defined target. To achieve this we need to open our eyes not to drive blind – we need to have information about left volume of fuel, temperature of the engine or distance to our target in km or time. In this article I want to focus on reporting – getting or creating information from the project and putting them together to client oriented reporting. This reporting brings condensed information to the surface of the data cube to allow the responsible participants in a project (clients of reporting) to steer the project to success.

2. Overview of the theory of reporting

Reporting in general is based on information – information is based on data. Data are undefined and various and information in difference to this has the target to be given to someone – so "to inform". Reporting is part of the live cycle of Project Management and in detail part of the Controlling part (O'Halloran, 2015, p. 9, 15). Reports are based on information and allow management (in combination with their experience and education and targets) to get an overview, orientation and basement of decisions (O'Halloran, 2015, p. 9, 11). Here we want to focus on reporting and we assume that project data are available and information can be used for project reporting (if not: see chapter 3).

Based on information we can have various types of reports. The following table shows different kinds – we will mainly focus on regular written reports. (Djenchuraev, 2004, Chapter. 2.3, Alexander, Britton, Jorissen, 2007, p. 20 ff.; Higson, 2003, p. 29 ff.)

Communication Methods	Methods / Tools	When
Formal written	• Letter • Report • E-mail, Fax • Project Plan • Minutes of Meetings	• Customer meetings • Team Meetings MoM • Steering Meetings MoM • Change request • Corrective Actions
Formal verbal	• Presentations • Speeches • Meetings	• Steering Presentations • Team Meetings
Informal written	• Memos • Notes • E-mail	• Team member information • Sponsor´s information about meetings
Informal verbal	• Meetings, • Chats	• Conflict talks

Graph 1 – Kinds of Reports

Reports are distinguished between internal and external reporting (Stice, Stice, 2006, p. 9/10) and this means we differentiate between the recipients of reports (within in the company or outside like clients and shareholders). We also speak about internal and external reporting if we distinguish not the recipient but the basement of the used figures. Figures based on management-accounting (they don't need to fit into the legal framework of accounting but can follow company-internal economical needs) and figures from official (= external) financial accounting (Böckler, 2010, p. 4). In project reporting we have normally internal reports from both angles: we hand over reports within the company and use figures from Management-Accounting. But it is also possible to prepare project reports for clients (e.g. reports about progress in the project) and reports based on financial statements like for controlling of the real payment for our delivered client-oriented projects.

Reports are normally past oriented – the view to the "rear mirror" - because we have a lot of data about the past. Financial reporting for example can just be based on real booked figures of the past – it tries rarely to see to the future like to foresee dangers (reacting with creating provisions) but chances are even not allowed to be included. In project reporting it is needed to see everything in a neutral way – we want to see chances and risks. If possible we even try to foresee the future and include as much information to our reports which are lying in front of us like risks, estimations of our suppliers or future oriented KPIs from Earned-Value-Management like EACc and EACt (Estimate At Completion - costs and time). (Wetekamp, 2015, p. 46). If we perceive NPV-based business cases as reports they are even 100% future oriented – they are the basement of the project decision itself.

In general the theory of reporting is very much based on long-term reporting of a running business within an organization. But project reporting has to take into consideration that projects are unique und therefor reports for various projects might be various. An internal campaign about cultural change of the employees needs a different and unique reporting than building a new headquarter for these employees for example. We will come to this point in chapter 3 where creating reports will be the main part.

To sum it up: Project Reporting can be seen as mostly newly created. It is an acknowledged information flow prepared by project controller to inform Project participants, leader and stakeholder with decision orientated data. We report about future and past oriented data.

The next chapter now is the core of the assay with focusing on how to create a suitable project reporting for concrete cases.

3. The Toolbox of Reporting in Projects

The author presents in chapter 3 seven reporting methods that promise success in project reporting and with this in project management. Each of the techniques will be illustrated with a brief example if needed and summarized in a key-sentence. The perspective we take in this chapter is one of the project controller – so we have the duty to prepare reports (compare: O'Halloren, 2015, Page 13, 38 ff.).

3.1 Although projects are unique we can use or can install a long term reporting infrastructure

Reporting is based on data and structured criteria for the data selection. Every IT-system in bigger companies provides costs- and revenues-collectors. The structure of costs in kinds and periods and plan/actuals/forecast is preinstalled. These tools support the normal running business of a company as well as projects. They are known by all managers and support reporting automatically. Extended tools for project management allow in addition creating standardized critical-path-graphs, Gantt-diagrams or risk-reports. Apart of this we need to create reports with individual tools (see 3.2).

- ⇨ Project reporting should include well supported reports known to everybody.

3.2 How to create a new report in 5 steps

The following 5 points allow creating new reports (uniqueness of projects!).

1. Target setting - To create a report starts with analyzing the project idea. It starts with the target you want to achieve. This can be the high level target of the whole project or a supporting sub-target. Write it down.
2. Give a precise title to your report which shows in one or a few words what you want to show – it can be the name of the target (from 1) or the trigger to achieve the target.
3. Define the target in concrete figures. Use the system of SMART-target-setting for this and the project description.
4. Define the system of getting this defined figure(s) in actual data – so find out how to get these needed data
5. Install the report and connect it with the information flow (including testing and asking participants if the required report hits their expectations)

These fife steps will get clearer with a small example. Imagine your project is to extend the marketing activity of you bicycle store and you want to start marketing the first time via internet. So point 1) would be "getting new clients via Internet" and point 2) would be the report title: "additional clients caused by internet". This target must now be well defined in a concrete way like "500 new deals per month" – this would be point 3). After this you have to care about point 4) the actual data like asking all unknown clients directly at the cash desk how they got known to your shop and your products. If you offer beside internet marketing also direct internet shopping and delivery via parcel service it is easier to get data because you can just count the internet-deals. The last step 5) is now to install the data-flow on a regular basis and show the data (plan, actual, forecast…) in an attractive way to the recipients of the report. The recipient has now to perform two additional steps – the analysis of data and to counter steer if needed.

- ⇨ Project reports should be created based on individual project targets and make these targets operational (SMART) and reportable – our task is the concrete installation of the information flow.

3.3 How to support step six and seven

After performing step 1 – 5 we can hand over the report to our recipients. They have to analyze the figures (step 6) and react on it (decide, counter steer, do nothing…) in step 7. These steps are not part of the duties of project controlling. But we can prepare them and help the decision takers. Our instrument for this is commenting the reports in addition. Good reporting includes the part of commenting the figures as if the controller would be in the shoes of the decision taker. We should understand the figures – should point on difficult or impressing content – should reduce worries or increase attention and even recommend what to do.

- ⇨ Project reports should include a comment to the recipients what they can see and how they could react.

3.4 Structure the reports according to headlines – than differentiate

If you steer an airplane you have to care about different dimensions of your flight in the same time. It is important to have information about "where you are" and about "security in the airplane" and "what about the resources we need". So the recommendation is at first to find out the general needs of the project manager (pilot). In a project the general need can be summarized like this:

1. Is the project on the right way in relation to budget or profit?
2. Are we in time and will we be ready in time?
3. Is the client and other stakeholders satisfied or will they be satisfied?
4. Is the quality of the project as planned?
5. Are our resources ready and prepared?

On the next level we can distinguish concrete reports like in the area of budget and profit the following reports:

1.1 Planned and spent costs
1.2 Prepayments of the client
1.3 Possible penalties and risks
1.4 Expected profit.

So the first step is to check point's 1-5 if they are sufficient or if we can reduce or have to extend the general headlines of reporting (maybe we have a charity project with different scope?). After this we can differentiate the headlines down to the concrete names of the report as mentioned above.

- ⇨ Project reports should include different areas of reporting like time and costs and progress and then should be differentiated to concrete reports.

3.5 Structure the reporting according the urgency and regularity of the items

If you drive a car you get information second by second because the traffic around you can change immediately – for example a ball of playing children falls to the street. This information you need second by second. Move these reports directly in front of the eyes of the guider. Other information is important and regular but not in every second needed like to be informed if you have to look for the next patrol station. In this case it is enough to install a report which informs you "just in case" so for example a signal lamp which catches your attention if needed "lack of fuel!". Other reports might never be delivered like if the engine is too hot and you should stop it

immediately. For years you will not be disturbed by this report – but in case it happens you will be warned immediately.

Also in project management you need regular reports like “Project in time?” or “resources prepared?” and you need to send reports in case of special events like “risk ‘A’ has occurred” or “client has paid”.

- ⇨ Project reports should be structured and delivered according to the selective need in the center or periphery of the field of vision. Avoid unneeded information.

3.6 Imagine that you are far away from the project but you still have to steer it

If you drive a car you are sitting in the driving seat and you observe the traffic around you every second. But in project reporting it is not possible to be in place every second. To select the needed information in the right way it helps to think in this way: “If I have to run my business, to drive my car or to the steer my project from my home office: what would I need to be still successful?” If you are the project manager of building a bridge, is it needed that your office is beside the bridge? If you introduce new software to your global acting concern is it needed to travel all day and be in place all over the world? The right information for reporting you will put together for your clients of reports (Owner, CEO, Project manager…) if you keep in mind that they might stay at home or in holiday location and still should be able to steer the things. Coming back to the cockpit of a pilot I state, that I guess it would be possible to steer the airplane from home by installing the cockpit at home because they almost do not use the small window in front of the airplane but all reports provided by the engineers.

- ⇨ Project reports should be created that way that you imagine: “the recipient of the report should not be forced to travel but to sit at home or in office and steer with your reports”

3.7 Project Reporting on Different Levels (Stice, Stice, 2006, p. 8 ff.)

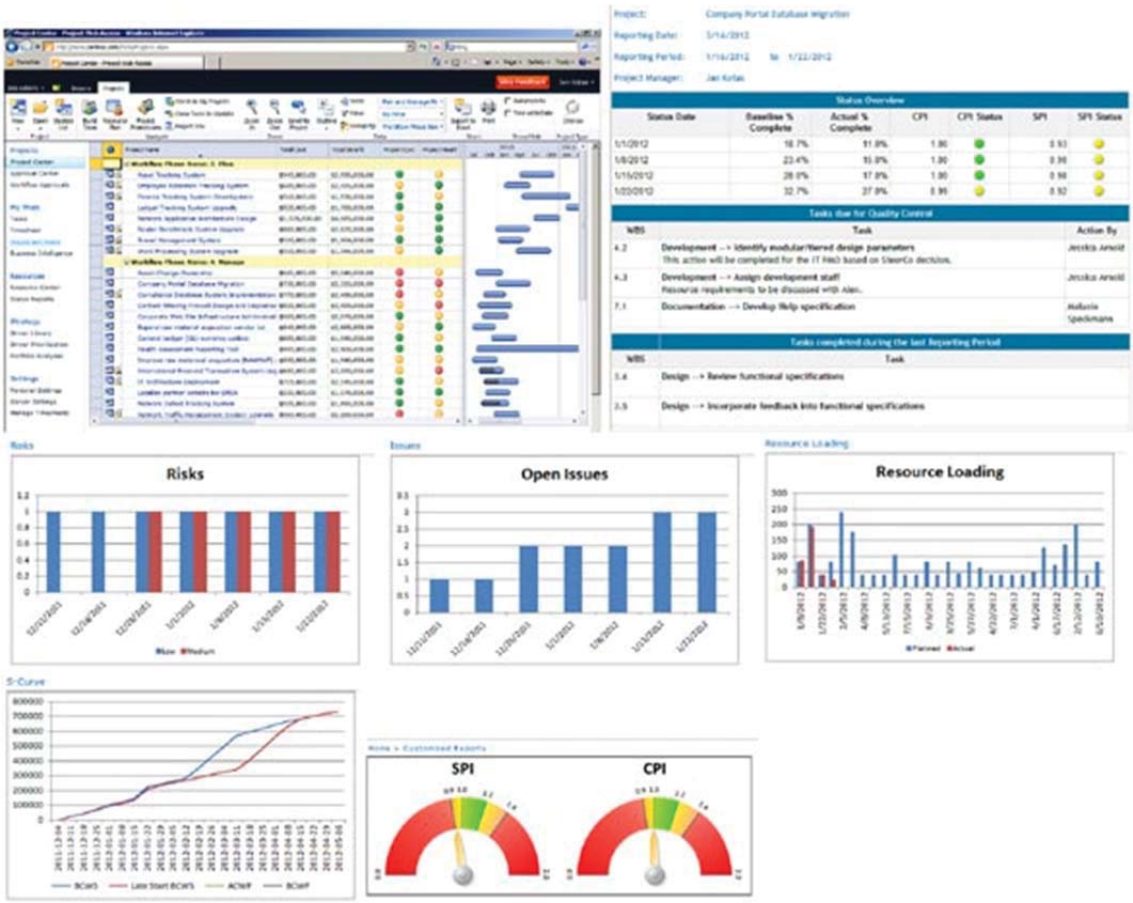
If you lead a company performing a project portfolio of 20 projects in parallel beside to your normal running business it is needed to aggregate reporting on a very high level. In the following example you see one project report for high level management.

Project	Description	Respon-sible	Schedule	Cost	Issues/Risks
SEO (Sales Efficiency Optimization)	Sales and Customer Service optimization in RWE Polska	xxxl FS			
SWORD	Closing of the company planned untill the end of September	xxx PE			
Gas power plant	Building xxx	xxx PR			
E-mobility	Implementation of power supply column	xxx PR			
EC xxx / Biomass	Modernisation of EC xxx	xxx PR	Suspended in March		
RGC	Building of a new credit risk management system	xxx FC	Suspended on January 25		

Graph 2 – high level project portfolio reporting (Internal Source RWE Polska 2010)

It is visible that you can read this report within 10 seconds. You even don't need to read the title of the different projects – it is enough to see "all is ok – green – green – green – the only yellow one has a comment to explain the color – also ok – done"

The level of reporting for the project manager or the client of an external project must be different - still on a high level but specific for a project. We need information on this level about time, issues, costs and some KPI from Earned-Value-Management like SPI/CPI (Schedule/Cost Performance Index).



Graph 3 – Standardized Detailed Project Report (folies.net, 2016)

Both shown levels can be used in general in the same layout for every company performing projects. So high level reporting is characterized by possible standardization.

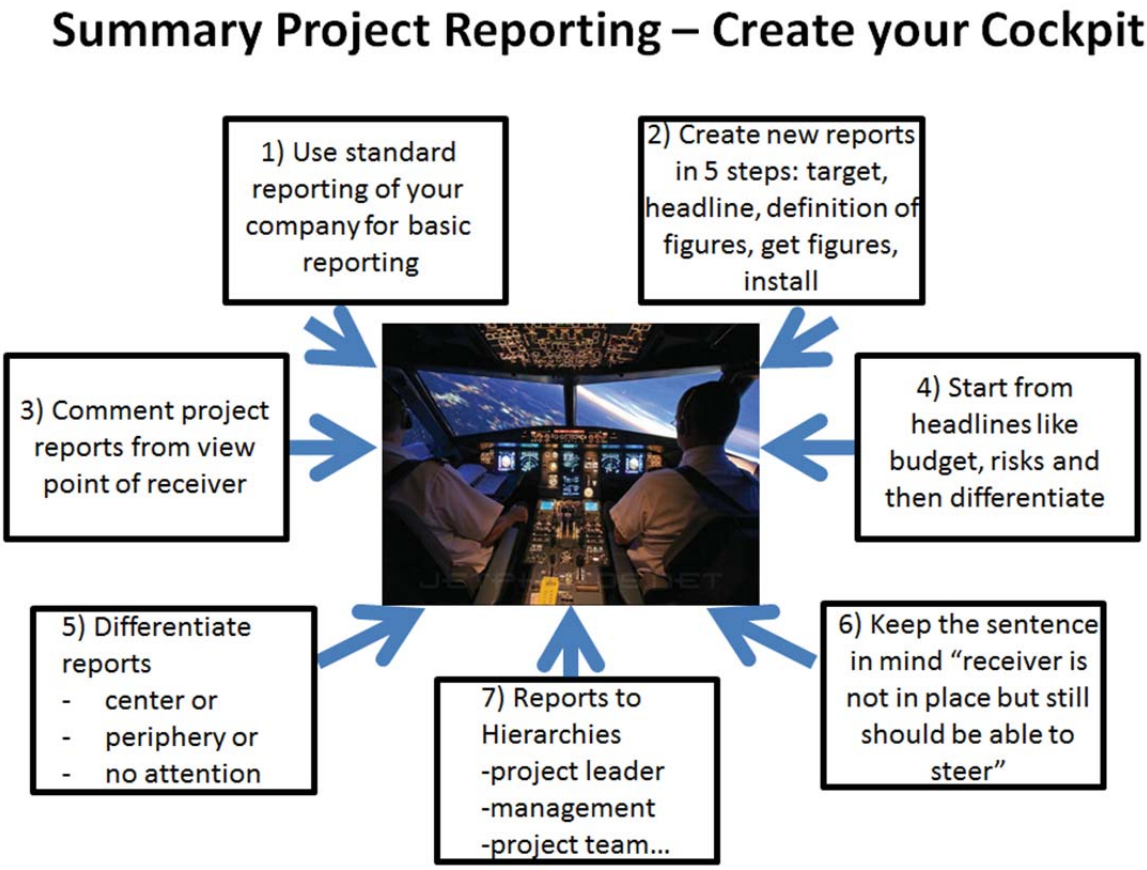
Now going to the level of uniqueness in projects you have to be flexible and able to create new reports. We need reports for individual situations created for individual purposes. If your project is to build a pyramid you might need a report about "logistics of block of stones", if you introduce a new communication system to your company you have to find an overview about the percentage of already educated future users, if you start a marketing campaign for your product in social media you have to report about additional clients coming from social media. How to create new reports is a specific challenge for project reporting because the uniqueness of projects causes the need of creating new reports (see 3.2)

In general reports must be client oriented. Don't send all information to everybody. Keep reports interesting and provide them when needed – an inflation of reports reduces the value and the interest to read.

- ⇨ Project reports should be given accordingly to the level of project recipients. Do not send too much information because this will reduce the value and perception of reporting.

3.8 Summary: putting all together in a cockpit for projects

A cockpit is defined as the working place of the pilot. From the cockpit the flight is steered. Reporting in this sense means to provide all needed information to the project manager in a condensed way to one known place to a defined time. We take this metaphor of a cockpit to summarize the content of chapter 3:



Graph 4: Project Reporting – create your cockpit

4. Summary

Successful project management means to steer a project to the defined goal. Disturbances, overconsumption, quality failures and regular project information must be delivered by project controlling regularly. Reporting is the basement of management, getting the needed information about the project and taking the right decisions. There is no flight without cockpit – no car trip without transparent front windshield and no project success without project reporting.

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THE APPERANCE OF STEWARDSHIP THEORY MODEL IN THE FAMILY BUSINESS

Éva Málovics

malovics@eco-u-szeged.hu
associate professor
University of Szeged
Kálvária sgt. 1., Szeged, Hungary

Gergely Farkas

farkas.gergely@eco.u-szeged.hu
lecturer
University of Szeged
Kálvária sgt. 1., Szeged, Hungary

Szabolcs Imreh

iszabi@eco.u-szeged.hu
associate professor
University of Szeged
Kálvária sgt. 1., Szeged, Hungary

Dóra Sallai

sallaidora9@gmail.com
BA student
University of Szeged
Kálvária sgt. 1., Szeged, Hungary

Keywords: family business, stewardship, familiness

Abstract: We examine the steward behavior in family businesses. We made in-depth interviews with ten entrepreneurs. We used the grounded theory method for analyzing stories about culture, innovation, communication in the firm. From the results we can see, that there are many appearances of stewardship theory in participating family members' narrative stories about business. Also in case of family businesses the company problems are common conversational topic at home. Managers suites themselves into a parental role and this starts prosocial behavior even in non-family employees. This way stewardship gets a part of organizational culture. This can be in connection with the familiness as a resource, but it needs further study.

1. Introduction

The paper examines the perception of the steward behavior in family firms. In stewardship theory, the manager is not self-interested, but a long-term oriented altruist. Based on strong social and emotional bonds the manager wants to follow financial and non-financial goals according to the needs of the family.

Our research – as a part of a bigger study – examines the context of culture - knowledge sharing - innovation chain in family SMEs. This study shows the results of the in-depth interviews done with family entrepreneurs as a qualitative part of the empirical research. Distinctive features of the family businesses are the appearance of the agent problem, and the appearance of the stewardship attitude as a positive effect of the family influence. In the interviews we were looking for the manifestations of the family influence, also the interpretation and perceived importance of the family influence on

business. The results, based on in-depth interviews with 10 family entrepreneurs, are certainly not representative but contribute to the deeper understanding and realistic interpretation of the examined phenomenon.

2. Stewardship theory in the family business

The literature does not contain a unified definition of family businesses. According to Wimmer, we define family business as a business owned by a family or an association of families, and the family/families has/have a decisive influence on the development of the enterprise. [13] The influence of the family can manifest itself in relation to issues of organizational culture, personnel policy or management decisions. Their main features are the result of the strong connection between the family and the enterprise. Based on this connection they can be considered a separate quality business entity. Two social systems with different logics overlap and interact with each other. The definition above is rather broad, implying different size enterprises, where a family is the majority owner.

The family provides a special resource for the business, also called familiness [7]. This can have an impact resulting from the strong interaction between the family and the enterprise. Positive emotions increase the family members' motivation and them willingness to sacrifice, while negative emotions can generate destructive behavior. Accordingly, family businesses are characterized by a complexity that increases the sensitivity for inner conflicts and makes them particularly vulnerable in critical situations. For a family business, familiness can represent additional resources, but it also can have an opposite impact and even peril the existence of the enterprise. [7]

This form of business includes at least two connected social systems that follow different goals according to Schlippe. [11] In order to understand the conflicts in family businesses, we must see the different currencies of the different systems. In a family, the expression of the strong attachment or love for each other is important in an indirect or symbolic form. In a business, people bring their labor, and they expect remuneration on a short-term. Appreciation is certainly important in the businesses as well, but nobody gives up his/her remuneration only for being thanked for something; however, parents do this for their children.

In stewardship theory, the manager has long-term goals and sustainable development is important contrary the viewpoint of the agent-principal problem, where the agent seeks his/her interest like a homo oeconomicus. The goal of the steward is "to do a good job, to be a good steward of the corporate assets". [5] Strong connections between actors is necessary, and they should relate to the same social network. These criteria are usually given in the case of family businesses. [3] In the case of family businesses, the stakeholders do not connect with a formal, written contract to the firm. The head of the family does not promise a better Christmas gift if the firm performs well. However, the members will be loyal to organizational goals because family well-being and honor depends on the firm. [1]

Entrepreneurship for the leader is a tool for achieving personal and professional goals. It is peculiarly true for family businesses, where more family members can pursue these goals. [6] Family business membership has a value, at least a distinctive value in the local community, what also strengthen loyalty. [12] Succession also enhances the long-term goals, because in the process not just knowledge and power is transferred, but the manager wants to deliver the firm assets in the best possible state for the successor. [9]

Miller et al. [1] describe the scientific knowledge about stewardship in the family business as a perspective of the organization. They delineate three common forms of stewardship. First is continuity, what ensures the long-term survival of the family business for the benefit of the later generations. Second is the organizational culture, what motivates and makes employees a loyal community. Third is the strong connections with outside stakeholders, especially with the customers, because these connections can help to pull through a financial crisis.

Three behaviors connect to the continuity aspect. [1] First is the long-term thinking, what takes into account the interest of the next generation. The less growth orientation, more conservative investment strategy can be the effect of this meanwhile, the family businesses spend more on R&D, and innovation processes. This is because they know these help the long-term survival of the firm and they are less shackled by short-term financial indicators. Second behavior is related to the reputation in the market, what also helps the long-term stability, because better reputation causes more customer loyalty and helps to keep up the market share. Family businesses give more factual, valid information about they products or services to maintain the reputation of the family. Third behavior is the building of the market share what also helps to "solidify the business for the future [1].

The community is the second aspect. Most firms try to build a strong organizational culture because a motivated and loyal employee community is good for business, but Miller et al. [1] emphasize the importance of it in family businesses. Studies what they cite state that these firms organize more training with extensive topics and to make sure that management and employees can cope with the uncertain future problems. Employees have a wider responsibility and role than in the case of non-family businesses. They are flexible in help to find the right employee for the right position or to create informal communication networks in the firm. They are also tolerant of the work schedule problems and work from home. They accept women in management more easily than non-family firms. This behavior is also interesting from the viewpoint of social transaction theory because the manager can be a model for prosocial behavior. [10] The reciprocity based on the following of the model behavior can lead to a stewardship culture in the organization.

The third aspect is focusing on the outside stakeholders, mainly on customers. Family businesses tend to extend the relationship with the customers. It does not happen just at the time of transactions, and they exchange information not related to the transactions. Because of long-term goals they want long-lasting relationships too. Miller et al. [1] mention many things about this behavior what is typical of family businesses. The managers of the firm meet the customers more often. This increases trust, what lowers transactional costs. Of course, this works only if the manager has some marketing skills. The firm can satisfy personal needs, and alter the offers for these customers. A convenience store is a good example for this: the room is small for a big supply, but based on local customer needs the shop can make an ideal mix of price and quality. This makes loyal customers because they find what they really need close to their home.

The result of stewardship is the collective utility instead of the fulfilling of personal needs. [14] While the agent-principal problem is less frequent in the family business, stewardship is not only a possibility, but it is almost inevitable because the strong social bonds and common values. The perceived stewardship can be different in the case of non-family employees. According to the research of Davis et al. [4] the family and non-family employees have similarly high loyalty where stewardship exist, but the difference in the favor of family employees is still statistically significant. Non-family employees usually know that a family business manager will prefer relatives even if stewardship culture is strong in the firm.

3. Results and Conclusion

The qualitative part of our research is based on 10 pieces of 1-2 hour-long in-depth interviews with 7 men and 3 women. They were analyzed by the grounded theory method [8]. We tried to collect broad reports and detailed information, what can let us take an insight into the world of entrepreneurial experiences. Our aim is the mapping of the entrepreneurs' knowledge from the inside and understanding their narrated experiences. [2] The analyzing of the interviews was done by a constructive and interpretative approach, we were trying to study the meanings, intentions and actions of the respondents, and we tried to follow the way that can be seen in the data. As it is described above, we do not intend to test hypothesizes, but statements can be formulated about how the people of the research see the reality. Our research question was the following: Does the stewardship theory appear in the text, and if so, how and what does it mean from the viewpoint of the family business?

According to the GT method during the analyzation of the text first we created definitions, then we organized them into categories and finally we investigated how these categories are connected to each other. The categories and definitions created by the analysis are in table 1.

Table 1.: Created categories and definitions

Categories	Definitions
Ensuring continuity	Training The transfer of the family values. Socialization partly at the company Consulting Sacrifice „Continuous" availability
Organizational culture - stewardship culture	„The right person to the right place!" Loyalty Love, staying together Care Training and development Informal communication Economical aspect Reciprocity
Nepotism	Good acquaintance Missing competency Care with the co-workers as family members
Close, long-term external relations	Relationship with customers Predictability Reliability Quality orientation Consumer orientation

Source: Own construction

Entrepreneurship and family topics do not separate in the frequent and informal communication about the issues between family members. For those who take part in the business, borders have faded. Family members live with the firm and know every small detail of it and also they discuss it with each other in an informal way. This method of communication flows into businesses and influences the management style. They have a strong psychological ownership, so they make significant personal financial sacrifices and they put a lot of effort in the business for the growth. They think the cohesion of the family means a resource in hard times because the company can adapt easier to the changes of the environment. Owners have a caring attitude, and non-family employees also acquire this method so it becomes the part of the organizational culture. Even in the case of basic inadequacy the selection method for succession is basically about nepotism. Furthermore, in the examined cases they prefer people that they know besides family members and will hire them even if their personality or knowledge do not fit for the job. Acquaintances seems reliable for them, and they are rarely fired because of the personal connections. The managers make countless efforts to find them a right task even if it is obvious they are not suitable for the job.

The stewardship theory is in strong connection with the familiness. Due to this central phenomenon the altruism that is typical in the family flows into the company. The communication about the enterprise is also often a topic of informal conversations. The family managers lead the firm with a strongly caring attitude, and it leads to trust and loyalty in the enterprise. It can create and strengthen the same caring attitude in non-family employees.

We found that the respondents live with their firms, they are familiar with them deeply. The founders highly identify themselves with the enterprise, where with huge efforts they achieved a lot of results. The family values and the atmosphere flows into the company. The trust, co-operation, safety and good mood also spread in the business. The entrepreneurs are talking about a 'family business

climate'. The stewardship attitude of the managers can be easily spotted in the interviews. They aimed to create an organizational culture, what can lead to the development of a community of motivated and committed employees.

Managers suites themselves into a parental role to take care of their workers and they are trying to develop them. The role and responsibility of employers are wider, they are more flexible about everybody to find their suitable tasks, they support the formation of informal relations in the firm and also more flexible about working time. We found several elements of the stewardship theory in our data. The prosocial behavior appears in the perception, in the thinking and in the corporate relations. According to the respondents it can be favorable as well. Certain conditions are needed for this, that are more common in family businesses. That is why it is important to study the specific processes of the family businesses. Despite all contrary assumption this form of enterprises has not lost from its popularity in the modern capitalist societies. Their managers are striving for the transgenerational survival as it has been shown in our research. The explanation of their behavior will be a relevant scientific question in the future. In the case of the family businesses it can be a demand for the scientific support of their decisions with more and more efficient management theories.

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MANAGING SUCCESSFULL PROJECTS DRIVING BY ENTREPRENEURSHIP ENERGY

Dr.Sc. Sergey Bushuyev[a], Dr. Denis Bushuiev[b], Dr. Ruslan Jaroshenko[c]
SBushuyev@ukr.net
Project Management Department
[a,b,c] Kiev National University of Constriction and Architecture, 37 Povitroflotskiy pr, Kiev, Ukraine

Keywords: project success, model, entrepreneurship, context, organization development.

Abstract: Management of successful projects and programs on the basis of entrepreneurship for development of organizations is considered.

1. Introduction

The success of development projects and programs depends on two groups of factors: (i) the competence of organizations in managing of its development projects and programs; (ii) "Entrepreneurial spirit" that is formed by the leadership of the organization and by the initiator of the project, and which support progress towards successful completion of the projects. The success of the project, as a management category, has contradictions which are formed as a result of different views of the interested parties. Thus, each of the key interested party has its level of competence in project management, and may have diametrically opposed views on the success of the projects and their products.

Entrepreneurial energy of various interested parties promoting the project contains contradictions which are to be accounted for by the organization's leadership in project management processes. Entrepreneurial energy depends on "entrepreneurial potential" available in the organization and the key interested parties. It is a set of orientations for success, individual and collective responsibility, freedom of expression and creativity (Grachev, 1993). Entrepreneurial potential is a socio-determined set of features and capabilities for organizing and operating a business, which entrepreneurs could possess. Most often, the business potential is characterized by such properties as efforts to promote economic innovations, forms of implementation of the role function, the final product of economic creativity, ability to take risks, creativity, leadership ability as an entrepreneur, and individual psychological characteristics of the entrepreneur as management skills, independence in the selection and decision-making ability to respond to changes in the economic and social situation (Helfat, 2003).

Summing up all these definitions and properties in the category of concepts and tools for project management, we should note that the entrepreneurial potential determines the technological maturity and organizational competence in the management of projects, programs and portfolios of projects (ICB OCB®, 2014).

2. CLASSIFICATION OF PROJECTS ENTREPRENEURIAL ENERGY

To study the mutual influence of entrepreneurial energy and project for development of organizations, a system of indicators of its condition and sources of forming the initial energy and renewable energy development should be identified.
To date, no method for assessing entrepreneurial energy for development programs exist. Evaluation of energy for development should be based on a hierarchical system of indicators (or a system close to it). The starting point for such a system of indicators should be a system of common values which will form the mobile context for development of organizations (Bushuyev, 2014).
Let's consider the classification of entrepreneurial energy in the context of modern concepts of development of organizations (Azarov, 2011). In its structure, entrepreneurial energy is multidimensional. The main factors that shape the classification system are: types of entrepreneurial energy, sources and types of energy carriers, catalysts and inhibitors of the application of entrepreneurial energy in development projects, as well as indicators of the impact of the environment (Jaroshenko, 2010). As for the types of entrepreneurial energy, it can be identified: *the primary entrepreneurial energy* (potential) and *the reproducible entrepreneurial energy*. The renewable energy is usually formed in the course of the project.
When classified by energy *Resources*, the three groups may be distinguished: financial and other resources that are invested in the program, knowledge and creative technologies used as catalysts of entrepreneurial energy management leadership and motivation parties concerned.
As for the *Sources* of entrepreneurial energy, it is possible to define the following classification features: external, internal, resource, technological, behavioral (motivational). Thus, resort, technological and behavioral characteristics may refer both to internal and external sources.
In the direction of the classification of *Financing*, the following features can be distinguished: external investment financial resources, domestic financial resources and other resources.
In the direction of *Knowledge and Creative Technologies*, we can define the following attributes - external and internal intellectual property (patents, trademarks, etc.), open innovation technology and know-how.
In the direction of *Leadership and Motivation*, we define the following features: management leadership, motivation of the parties concerned.

3. DRIVING PROJECTS BY ENTREPRENEURIAL ENERGY ON THE COMPETENCE-BASED APPROACH

Now, the terms "the energy of change" or "the energy of reformation" are often used in practice. In this case, the analogy with the motion in mechanical systems is used intuitively. Thus, energy is defined as a scalar physical quantity, as a general quantitative measure of movement and interaction of all forms of matter. Under the term "the entrepreneurial energy", we will understand the visible and invisible

activity of the actions of the project and other key concerned parties with using key resources, including knowledge, technology, and creative leadership, which provide progress of the project.

The presence of polar views on the existence and impact of entrepreneurial energy to the successful implementation of development programs were due to differences in the understanding of what the entrepreneurial energy means in the management of projects and programs.

Outside and external sources of entrepreneurial energy, leadership, intuition, rational thinking, appropriate emotions, needs, moods, associations and others may be included here. This set of characteristics can be modeled mathematically by means of a multitude endowed with additional mathematical structures (metrics, topology, etc.). Let's apply the hypothesis of the unity of entrepreneurial energy for sustainable balanced development of the organization based on the chosen strategy. However, under such general approach, the concept of the energy business will include completely different elements, such as energy sources, energy transmitters, amplifiers or transformers of energy.

In the development, the internal and external context of the organization plays an important role. By context, we will understand the behavior of the environment and system of contextual competences of the project team (IPMA OCB®, 2014), which links the activities of project management and operational activities of the organization. The operating activity of the organization is its activity aimed to produce products or services. In the development of contextual competences in project and program management, mobile context is formed, which is fueling the development of projects and operations of the organization. The theme of this research is formulated as a definition of the relationship of entrepreneurial energy, mental space and mobile context of operating and project activities of the organization for establishing effective mechanisms for the development of organizational competence and competitiveness.

The entrepreneurial energy in the management of projects and programs is often by enhanced by catalysts and hampered by inhibitors. Catalysts and inhibitors of entrepreneurial energy have their own structure. Elements of the structure of catalysts are: the presence of the special function commercialization of key decisions, the system of incentives for innovators based on the distribution of values obtained in the course of project implementation, metrics for values evaluation and integrated information for decision-making. Inhibitors of development projects inhibit the formation and restoration of entrepreneurial energy and have their certain structure. Examples of inhibitors may be "the belief that innovation will be implemented by itself", "the creation of development policy, forms the barriers to innovation", "sending all the problems to innovators" and others.

Structure of catalysts and inhibitors are complementary elements of the evaluation model for entrepreneurial energy of an organization in a particular situation.

Exploring a new class of energy, such as "entrepreneurial energy" in organizational systems, as a rule, the studies are concentrated on the psychology of the parties concerned and technical aspects of the implementation of development projects, the investment component, the economy of production and development projects.

Creating entrepreneurial capacity, the formation and reproduction of entrepreneurial energy are based on the incremental implementation of development projects and programs.
The hypothesis in this model is used under conditions where the entrepreneurial potential of the project will be formed on the pre-investment phase of the project, during the formation of the project team and key concerned parties.
To assess the entrepreneurial capacity of the organization in the field of project management, programs and project portfolios (PP&P), let us consider a model of organizational competence IPMA OCB®. The basic principles of construction of this model are: *completeness of description of the competencies for management of PP&P, their integrity and consistency, independence from the assessment system of organizational competence.*
The key concept of the model is the organization's focus on the next development spiral: Competence> Efficiency of Activity> Competitiveness. Thus, the organizational competence is divided into five classes IPMA Delta®.
Based on the previously mentioned principles, IPMA OCB®, Model of Organizational Competence, systematically displays all aspects of the organization's project activity, determines the necessary connections within the administration and management of projects, programs and project portfolios, takes into account the internal and external context. Thus, the model represents the process of converting of the mission, vision and strategy into results of projects and programs. The general scheme of the conceptual model, developed by the authors, for the application of IPMA Delta®.
Organizational competence in the management of projects, programs and portfolios (PP&R) is determined within 5 expert areas: Administration of PP&R, Management of PP&R, Human Resources, Material Resources and Integration Processes, Structure of Culture.
Let the organizational competence will be determined by the five areas:

$$K=<k_1,k_2,k_3,k_4,k_5>.$$

For example, the area of 'Administration of PP&P':

$$k1=\{G_{11}, G_{12}, G_{13}, G_{14}\}.$$

Thus, the estimation model of the area is formed by the R1 ratio and all of its elements. This relationship forms the convolution rule for evaluations of each competence element in the area. All the elements of organizational competence displayed in the context of the three axes (A): Strategic (S), Tactical (T) and Operating (O):

$$A=<S,T,O>.$$

The generated three-dimensional space determines the trajectories for development of organizational competencies. Complete description of all elements of the organizational competences model is given in IPMA OCB® Standard.
In assessing of entrepreneurial potential (potential entrepreneurial energy) for a development project or program, the basic sources of G-organizational competence in the management of PP&P, investments, resources, applied creative technologies and leadership of key concerned parties should be taken into account. Each of them is determined by specific gravity (V_G) and the impact on the success (S_G). The parameter of influence on the success of development projects and programs is an integrated index, which is to be determined in expert way.
The level of the potential (initial) entrepreneurial energy is defined as:

$$E_i = \sum_{k=0}^{G} V_{ik} S_{ik} \,,$$
$$\text{where } i = \overline{1,4}\,.$$

Reproducible level of the reproducible entrepreneurial energy is determined basing on the following relationship:

$$K_r = \sum_{k=0}^{G} V_{rk} S_{rk} \,,$$
$$\text{where } r = \overline{1,4}\,.$$

Specific level and impact on the success of development projects, their catalysts and inhibitors are based on expert assessments, and processed on the basis of qualimetry; they give the total normalized result of entrepreneurial energy at each phase of the project.
It follows from the applied analogy and from the definition of the potential and kinetic (reproducible) entrepreneurial energy that their level must be greater than one within all phases and steps.
Given catalysts and inhibitors, level of entrepreneurial energy is defined as:

$$E_C = E_i + K_r + E^K + E^I,$$

where,
E^K - normalized level of influence of catalysts to the entrepreneurial energy;
E^I - normalized level of influence of inhibitors to entrepreneurial energy in the implementation of development projects.

4. CASE STUDY FOR APPLICATION OF PROJECT ENTERPRENURIAL ENERGY

Consider application of proposed model for analyses of success development projects in company Ukrainian XXX.

Model creation and playback of entrepreneurial energy development program XXX Ukraine

Multiplier influence of the environment on the project of reforming 1.2

1. Pre-investment phase - model of entrepreneurial energy

№	Source and type of entrepreneurial energy	Weight of criteria	Milestone	Effect on success
1	External financial investments	0,3	01.01.2013	2
2	Internal financial investments	0,2	01.01.2013	1
3	Creative technology and open innovation	0,3	01.11.2013	0,5
4	Leadership	0,2	01.11.2013	2

The potential entrepreneurial energy *1.35*

Potential entrepreneurial energy based catalysts of change and innovation inhibitors *1.16*

Potential entrepreneurial energy based environment multiplier *1.39*

Catalysts of change

№	Name	Impact on energy	Validity	Impact of success
1	Special feature elements commercialization	Positive	01.01.2013	0,1
2	Positive incentives for innovators	Positive	01.01.2013	0,4
3	Average values innovators	None	01.11.2013	0
4	Metrics for assessing the value	None	01.11.2013	0
5	Integrated information	None	01.01.2013	0

Average *0,1*

Inhibitors of innovation

№	Name	Impact energy	Validity	Impact of success
1	The belief that innovation will be implemented by itself	Negative	01.01.2013	-1
2	Declare to everything to "think outside the boundaries"	None	01.01.2013	0
3	Transfer of innovation solely on the shoulders of engineers	None	01.11.2013	0
4	Create a development policy that creates obstacles for ideas	Negative	01.11.2013	-0,3
5	Transfer of innovative ideas for lawyers and accountants	Negative	01.01.2013	-0,7
6	Be very intimidated by the rejection of innovations	None	01.01.2013	0
7	Innovation is when there is a need for negative	Negative	01.11.2013	-0,6
8	Sending all problems "innovators"	None	01.11.2013	0
9	Interest of all to reach the sense of the idea	None	01.01.2013	0
Average				-0,29

There are same repeatable tables for <u>implementation and execution</u> phase of project. These tables have not included in description of case study.

Results of simulation presented in the next table

Dynamics graph of entrepreneurial energy	Energy level (potential)	Maximum level of entrepreneurial energy	Energy based catalysts and inhibitors	Energy taking into account the multiplier impact environment
Pre-investment phase. Potential entrepreneurial energy	1,35	1	1,16	1,39
The implementation phase. Renewable entrepreneurial energy	1,30	1	1,02	1,23
The execution phase Renewable entrepreneurial energy	1,75	1	1,17	1,40

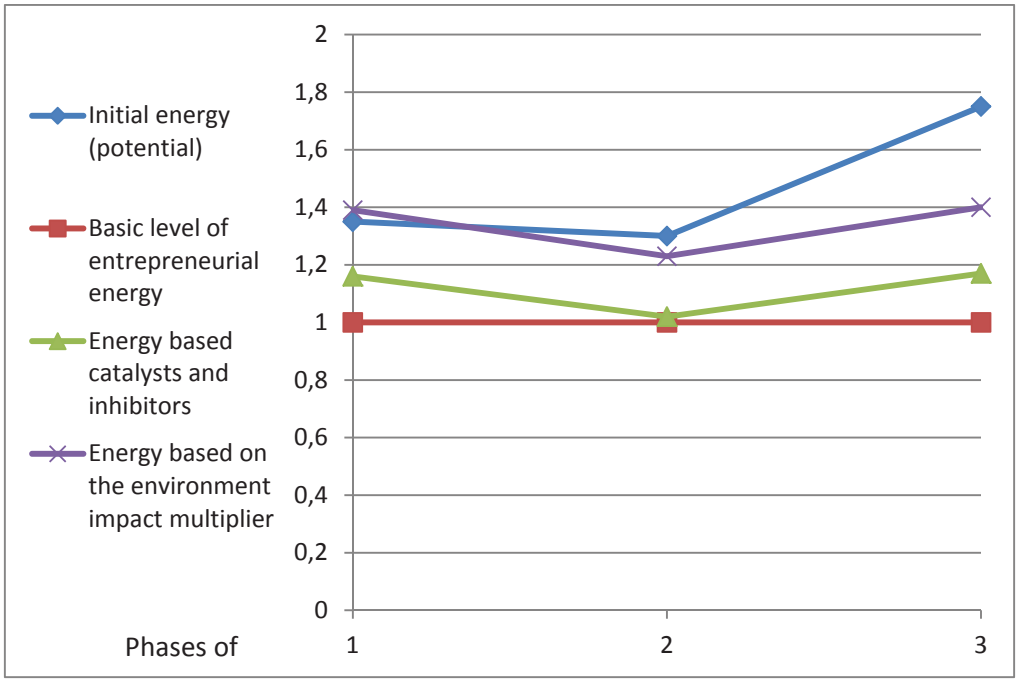

Fig. 1. Dynamic graphs of entrepreneurial energy

This case shows success of project from the point of view of entrepreneurial energy.

4. CONCLUSIONS

1. The proposed classification of entrepreneurial energy organization allows creating basic terminology and models of successful projects and programs based on entrepreneurship.
2. The evaluation model of business model on the basis of the IPMA OCB® Standard allows assessing both the initial and reproducible entrepreneurial energy of the organization.

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A NEW APPROACH ON BLENDED LEARNING INSTRUCTIONAL DESIGN: THE CASE OF *BLENDLEE*

Marcos Welker
welker.m@*blendlee*.com

Jolita Kiznyte
kiznyte.j@*blendlee*.com

Prof. Dr. André Dechange
andre.dechange@fh-dortmund.de

Keywords: *blended learning, project management, project management skills, skills' development, contextualization, scenario-based learning, situated cognition*

Abstract

Despite the emergence of new learning technologies, the field of competence development has suffered from a lack of effective methodologies and frameworks that integrate current technological, professional, organizational and experiential requirements. Traditional unitary approaches have faced challenges when trying to cope with the complexities of competence development in project management. Using a case study as a background, this paper presents a new and innovative way of creating blended learning instructional design and the results of its application on a module in a master's course on project management. The hypothesis is that factual information can be delivered using computer-based instruction (online) - as declarative knowledge held by students - whereas face-to-face time is saved for deeper social learning experiences.

1. Introduction

Nowadays, the market demand for highly applicable skills is more dynamic than ever and, as a result, educational institutions and training providers face the challenge of adapting their approaches to a more performance-centered learning that combines both efficiency and effectiveness and focuses on these dynamic market demands.

In pursuit of answers to this challenge, blended learning, as an approach to instructional design, has recently gained the attention of educators [1] [2]. In its simplest form, a blended learning course combines the best elements of two other approaches, online and live or lectured instruction, while also seeking to address some of their limitations [3]. Blended learning (or blended instruction) can benefit from both instructional methodologies, while the ways in which teachers are applying blended instruction in the classroom are becoming increasingly varied.

However, the simple combination of online and face-to-face sessions has so far not been proven to provide the expected efficiency and effectiveness from the point of view of performance-centered learning. The design of

blended instruction can represent the difference between the development of high performing or low performing professionals. When developing an efficient and effective blended learning course, the following points should be considered:

- How is the content created?
- What types of content are offered?
- In what amount and with what frequency are they offered?
- Are the new roles and responsibilities of the instructor adapted to the new approach?

A new approach to blended learning instructional design was developed and used in the module Introduction to Project Management of the European Master's in Project Management (EuroMPM) from the University of Applied Arts and Sciences, Dortmund.

Although other benefits were also observed, the main goals of the project were:

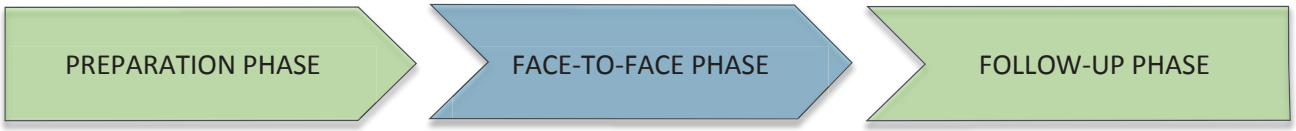
- To raise the learning performance in terms of a holistic understanding of project management, levels of information retention and students' practical skills.
- To offer more flexibility in teaching and learning.

2. Challenges in the development of project management skills

The development of project management skills is especially challenging [4] [5] as they require a particularly high amount of hard and soft skills as well as good decision-making and problem solving abilities. The inherent complexity of projects demands that key capabilities [6] be developed and present, even under immense pressure and stress. A lack of previous experience in this area on behalf of the learner can make achieving an understanding of the abstract nature and concepts of project management a particularly challenging task, making this an extremely difficult discipline to teach. Due to the nature of the competences required in such complex project scenarios, Egginton [7] has highlighted the need to hone specific professional behaviors which can only be attained through experiential learning [8]. Therefore, the approach to be taken in the *blendlee* case should not only be blended, but also be as experiential as possible.

3. Overview of the course structure

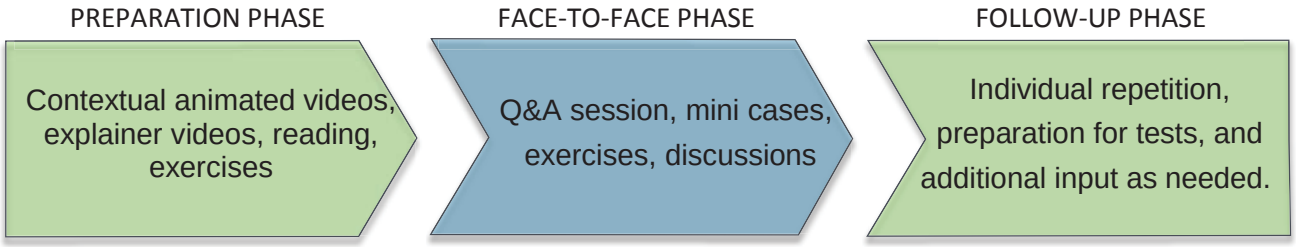
The structure of the course follows a basic three phase approach to each face-to-face encounter, which the authors call cycle or iteration. The students access the online content prior to the face-to-face sessions as a preparation segment and also after these sessions as a follow-up or consolidation segment. A diagram showing the basic three-part structure which forms the design of the course is given above (the online activities in green and the face-to-face activities in blue).



In summary, this blended approach to course design was shown to be an effective instructional strategy, providing a way to guide the students in practicing and organizing their knowledge.

4. Learning elements used

Part of the success of the course can be attributed to the types of learning elements used and the way they were developed. Each element is presented to the students at specific points in time and fulfils specific didactical purposes. The following list depicts the types of learning elements and the phase in which they are used:



It is important to mention that not all learning elements are used in every cycle. The decision regarding which elements to use depends on the complexity of a topic and its length. Additionally, some elements, such as discussions, were shown to be more appropriate only after a certain number of cycles as only then were students able to create the relevant connections between them, allowing them to engage in the discussions. In the following table, the online and face-to-face activities are explained in detail.

Online activities and learning elements	**Face-to-face activities and learning elements**
Animated story videos Short animated videos with the purpose of offering, through storytelling, the characters, real world examples and context to the topic.	*Professor's deeper explanations to content* Here students have the opportunity to hear the professor's deeper explanations on the topics they have already seen in the preparation phase.
Animated explainer videos Fundamentally based on motion graphics, these are short animated videos that seek to explain concepts at a detailed level.	*Professor's answers to questions (Q&A)* A 'questions and answers' session in which students are able to ask questions and the professor can ask questions of the students.
Professor videos with animations As with the animated explainer videos, the animated professor videos offer deeper explanations for the concepts. The videos also feature additional motion graphics to help illustrate the explanations.	*Professor's field experience* Offers students insight from 'within' the relevant life experience. In a non-blended approach this is possible, however there is usually not much time. In the blended approach there is more time because part of the content was given in earlier activities.

Third party readings These readings, from different authors and publishers, offer students a broader and deeper perspective of the topics.	*Discussions* Guided by the professor, students express their understanding, agreements and disagreements. As students have already received content, there has been time for their brains to assimilate the information and develop connections so that they can build their own points of view. Thus, the level of participation is high and discussions are rich in valid arguments.
Professor readings Those are texts written by the professor. Under the same category of learning elements there are also slides created by the professor. Specifically, these texts and slides could offer especial insights from the professor's perspective, thus customizing even more the course.	*Group work: mini case studies* Unlike the online mini cases, this exercise is focused on team work rather than sole knowledge. Students exercise their social, argumentation and analysis skills under pressure.
Peer review Exercises in which students analyze and evaluate other students' work (e.g. answers to questions; report). Each student checks at least two other students' work, allowing them to gain different points of view.	*Online test* Under time pressure, students answer questions related to a group of topics. Grades are received immediately after test completion. They can also reexamine their answers to know which questions they did not answer well and in which they marked the correct answers.
Online exercises These are not graded exercises. Their purpose is for the students to be conscious of how well they have understood the content. The exercises offer automatic feedback and are a tool for spaced repetition. Different types of questions are used, including true/false, multiple answers and drag-and-drop.	
Online mini case studies Students are presented with fictional and non-fictional cases, which they analyze, answering questions, proposing solutions and preparing for class discussions.	

5. The role of the professor

Until fairly recently, students received most of their knowledge from professors. As technology became more commonplace and information more democratic, students started to have more control over their pace of learning. However, even with the added technology, students still feel the need for the instructional dynamic of being guided by the professor.

With the blended learning approach presented here, the professor was no longer bound by the need to present the instruction in its entirety, thus leaving more class time to dive deeper into the topics and focus on personal interactions, expert opinion and exercising through case studies. Furthermore, the professor was better able to circulate among and interact with the students, allowing him to observe them more closely, detecting individual problems and providing timely feedback and guidance on class work or home assignments. The professor also served as a catalyzer for student discussions, bringing his own experience to the debate and asking tough questions to further stimulate students' thinking. This intense level of interaction also allowed the professor to develop a stronger rapport with the students.

Thus the role of the professor shifted to that of a mediator, a coach or mentor. By offering this environment of contribution, this particular blended learning approach also gave students a greater control and a more active role in the learning process, contributing significantly to student motivation and interest in class. Furthermore, by arriving at the class already in possession of a good notion of the topic, students have more confidence and participate in an active manner, unlike the passive learning experienced during the pure acquisition of knowledge. Overall, students' trust and self-confidence increased, while a change in the students' views regarding the professor was perceived, moving from that of knowledge-master to that of a mentor.

Worth mentioning is the fact that this kind of teaching approach was only possible because, for every cycle, students had already spent time, during the preparation phase, building an understanding of the context surrounding the project management topics.

6. Research in cognition to support the development of more effective trainings

Based on, among others, research in cognition, memory and learning performance, the approach offered contained a number of strategies in improving learning performance. Below the authors describe some of the key components, namely: situated cognition, avoidance of information overload, influence of sleep, influence of social interaction and spaced repetition.

Contextualization and the situated cognition

One of the pillars of the methodology was Kindley's [9] concept of situated cognition, which suggests that the best learning process takes place in the context in which it will be used, based on the idea that it is then easier to fully understand the information. This can further be connected to previous knowledge so that it is better acquired and retained.

In addition, attention is closely related to meaning which is, in turn, closely related to the retention of information. Thus, content must be meaningful in order for students to engage with it [10]. The combination of images, sound and text in a story attracts student interest and enhances learning achievements [11].

There is also evidence indicating that emotional arousal has an effect on memory systems and on behavior [12] [13]. Chemicals active during emotional arousal, such as adrenaline and especially norepinephrine, are involved in attention and in the consolidation and retrieval of memory.

Finally, storytelling can also be used to enhanced situation cognition. According to Schank [14], storytelling is an effective instructional strategy that promotes learning motivation and improves student learning performance. Other authors [15] [16] emphasize that digital storytelling is key to promoting learning achievement and should be merged with the curriculum in order to achieve the teaching objectives.

Shown below are some screenshots of the animated videos offered online for the students during the preparation phase.

In the methodology, the elements of context and meaning were integrated through the use of animated story videos offering examples of real-world situations. The challenges posed when creating context-rich training can thus be overcome with such videos as they make meaningful patterns, elicit emotions and demonstrate the relevance of the topics to the audience. In addition, animated stories can fill an emotional gap in a way that 'hard facts' cannot. We should, however, emphasize that the objective of the animated videos was not to serve as transmitters of knowledge or to replace other forms of knowledge transfer (e.g. by the professor or through reading). Their focus is rather to prepare the ground by offering context and leading students into a welcoming emotional and cognitive state that facilitates the uptake of the information presented.

The avoidance of information overload

Information overload is a common occurrence in traditional forms of instruction. If the student is presented with too many facts and figures, then the capacity to retain these is overwhelmed and the brain must discard information which does not 'stand out'. Thus, at some point, the student is no longer able absorb or even understand the information presented, leading to low performance [17]. This represents a significant waste of time and resources on behalf of both the student and the professor and should be avoided. To solve this challenge - i.e. to eliminate the waste – the following strategies were used:

- All unnecessary information was identified and then removed from the learning content.
- All remaining necessary information was sliced into smaller chunks of information.

The blended approach to this case study proved to be very efficient with regards to keeping students' attention and not overwhelming them with information. Small pieces of information were made available online and students had the opportunity to absorb small daily intakes. Additionally, during the period of the course design, several pieces of information were identified as either unnecessary or at least lacking the added value that would justify their inclusion in the core material.

'Sleeping on' important information

There is a broad scope of literature on strategies for improving the retention of information or long-term memory. There is a consensus [18] [19] [20] that sleep positively affects memory as meaningful connections are created during deep sleep. The strategy of 'sleeping on' information can be very effectively used in conjunction with the slicing of information. Thus, information overload is not only avoided, but also students have the chance to sleep between information chunks.

Although the influence of sleep in retaining information is widely known, it is still rarely used in course design and courses still focus on offering as much information as possible within the class period. However, when trainees are able to 'sleep on' the information given, this gives their brains a chance to solidify the content [20]. Findings [19] support the hypothesis that recently acquired information is actively restructured and strengthened during sleep, suggesting that REM sleep is deeply involved in the reprocessing and optimization of the higher order information contained in the content delivered.

During classes, it could be observed that students were able to not only recall information given in the preparation phase, but also make several associations, which could be attributed to the findings of Peigneux [19], that is, information is restructured and strengthened during sleep.

Spaced repetition

Spaced repetition takes place when students have the opportunity to repeatedly review the same information, preferably in a variety of means. It is known that information that is not repeated is lost [21]. This effect is illustrated by the so-called 'forgetting curve' [22], which pictures the decline of memory retention in time.

Information that is lost represents a significant waste in financial terms, temporal aspects and in missed opportunities. People tend to forget facts and figures which are not stored in the procedural (habit) memory.

Spaced repetition acts positively on all memory systems (declarative, working and procedural memory) and has a powerful effect on the ability to retain information [23].

Additionally, research supports the hypothesis that repeated information favors the procedural memory system. This corroborates the idea that trainees who participate in training sessions which value procedural activities (active and emotional) are able to perform accordingly in the future, even in stressful situations [13] as it broadly reflects a rooted procedural memory.

The design of the course, divided in three phases, allowed students to view information at least three times and in different forms (video, text, discussions, exercises).

7. Results and Conclusions

In summary, the blended approach used incorporated the following main characteristics:

- It was divided into phases;
  - preparation
  - face-to-face
  - follow-up (or consolidation)
- It possessed a diversity of learning elements, according to
  - each phase
  - the desired cognitive levels
  - each learning objective
- It was highly social and included
  - discussions
  - questions and answers
  - case studies
  - peer review
- It was based on research in cognition
  - contextualization (situated cognition)
  - avoidance of information overload (chopping of information)
  - sleeping on information
  - spaced repetition

As a result of this particular blended approach, a highly constructivist and cooperative learning environment was observed in the class and students were fully engaged both in the discussions and in solving the case studies. Difficulties in promoting a proactive and cooperative learning environment among students were not present. Moreover, students showed constant motivation and a consistent concentration on the learning tasks.

A usual challenge to blended approaches lies in the common non-completion of the out-of-class activities by the students. This behavior, however, was not observed during this course as most students (> 80%) accomplished the online activities. A reason given by students for completing the online activities was that they were ‘interesting’ and, in most cases, ‘short’, such as in the case of the videos, which varied in length between 1:30 and 3:30 minutes. Nonetheless, students reported having taken more than two hours, between researching and writing, to accomplish some of the more challenging activities.

The end-of-course questionnaire presented following numbers:

95%	The content motivated to learn, encouraged further research and helped understand the topics.
100%	Would like to repeat the same blended learning experience.
95%	Became even more interested in the subject of project management. (This means that if they were interested, or even if they were not very interested in project management, they became more interested after attending the course using *blendlee*'s approach).

At the end of the course, the authors gathered the following list of advantages and disadvantages of the approach.

Cons:

- ✦ Creation of the course design and the material is time-consuming and relatively challenging
- ✦ Creation of the material requires a high level of customization
- ✦ Maintenance of the material is laborious

Pros:

- ✓ Positive learning outcomes for the project management topics
- ✓ Motivation and engagement for students
- ✓ Motivation for the professor - classes become more interesting and dynamic
- ✓ Possibility for the professor of re-using the material in each semester
- ✓ Scalability – content can be used by any number of professors and classes
- ✓ Quality level standardization - students receive the same base material, independent of institution or professor
- ✓ Flexibility - content can be used in its totality, partially or mixed with additional material given by the professor

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INTERACTIVE SOLUTIONS FOR COMPETENCY MANAGEMENT

Olga Mikhieieva

Olga.mikhieieva@fh-dortmund.de
Dortmund University of Applied Sciences & Arts
Otto-Hahn-Str. 23, 44227 Germany

Keywords: competencies, learning in project management, career path

Abstract: A growing demand for constant development of knowledge and skills requires new tools and approaches that ensure flexible planning and realization of a study process. A competency-based education has had a recent resurgence as technological tools have made individualized instruction more feasible [1]. Competencies represents abstractions of work-relevant human behavior and introduce a promising concept for making human skills, knowledge and abilities manageable and addressable in a wide range of application areas. Competencies' representation, if they are defined for a particular study course or a development program, give a chance to an employer to understand what can be expected from a learner. Project Management (PM) sphere built up on systematic goal-oriented approaches is a natural environment for development and implementation of competency-based educational approaches. Such an approach, when an individual or organization can select and develop tailored educational programs in the form of a competency development path, can contribute to the so-called "projectification of learning". In other words, it is the learning throughout life that is managed in terms of competencies as learning outcomes and planned as a sequence of connected steps. This paper provides an overview of trends and requirements for learning in modern project management in terms of competency management. The findings of this overview are used as a basis for the study on a conceptual interactive solution for an individual's competency development path.

1. Introduction

Due to projects' complexity and versatility, the set of competencies required for a project manager is composed not only from specific PM competencies, but it also includes technical competencies, business competencies and cultural and ethical awareness. Acquiring PM competencies, keeping them state-of-the-art, becomes an issue, even for those project management personnel who belongs to a project-oriented organization [2]. The hopes for the benchmarking are not justified since it is a local tool failing to provide effective schemes for convergence (combining knowledge) of different domains, forming new, more effective systems of knowledge [3]. Competencies acquired by an individual through the academic education, according to professional standards and within different technical domains or industries need to be integrated to facilitate and ensure purposeful career management.
The development of learning and teaching tools, methodologies and pedagogical approaches in the form of learning outcomes with the usage of IT-based practices [4] is a universally recognized need. For example, it can be flexible learning paths, blended courses, virtual and real mobility, ontology, simulation, etc. Scholars assume that project work will take different shapes and forms in the future, stating that project professionals will be working in the virtual world by 2020 [5]. Thus virtual interaction is one of the trends in modern PM. An individual's development path based on virtual interaction and competency management is a proposed study field to facilitate projectification and sustainability of learning. The conceptual solution for interactive competency development path in PM is the subject of the study.

2. Requirements and challenges for learning in PM

There are different requirements, trends and specific features that should be considered in terms of relevance for competency management and learning in PM.
During an individual's life cycle, three basic categories of purposeful learning activity - notably formal, non-formal and informal learning - can take place at different points of life cycle. An individual can acquire competencies not only through formal learning and practical experience, but via trainings – both in professional and non-professional directions, acquisition of certificates, foreign languages courses, different online courses, coaching and so on. Thus learning deviates from linear progressive pattern and can be represented more accurately by a learning curve (see fig.1). For example, in case of an IT project manager formal learning forms and outcomes consist at least of the sets of academic, IT, and PM elements. But the overall set of individual's competencies in PM is built up as well on the basis of experience and learning in informal and non-formal ways, such as living abroad, participation in virtual communities, trainings and seminars, etc.

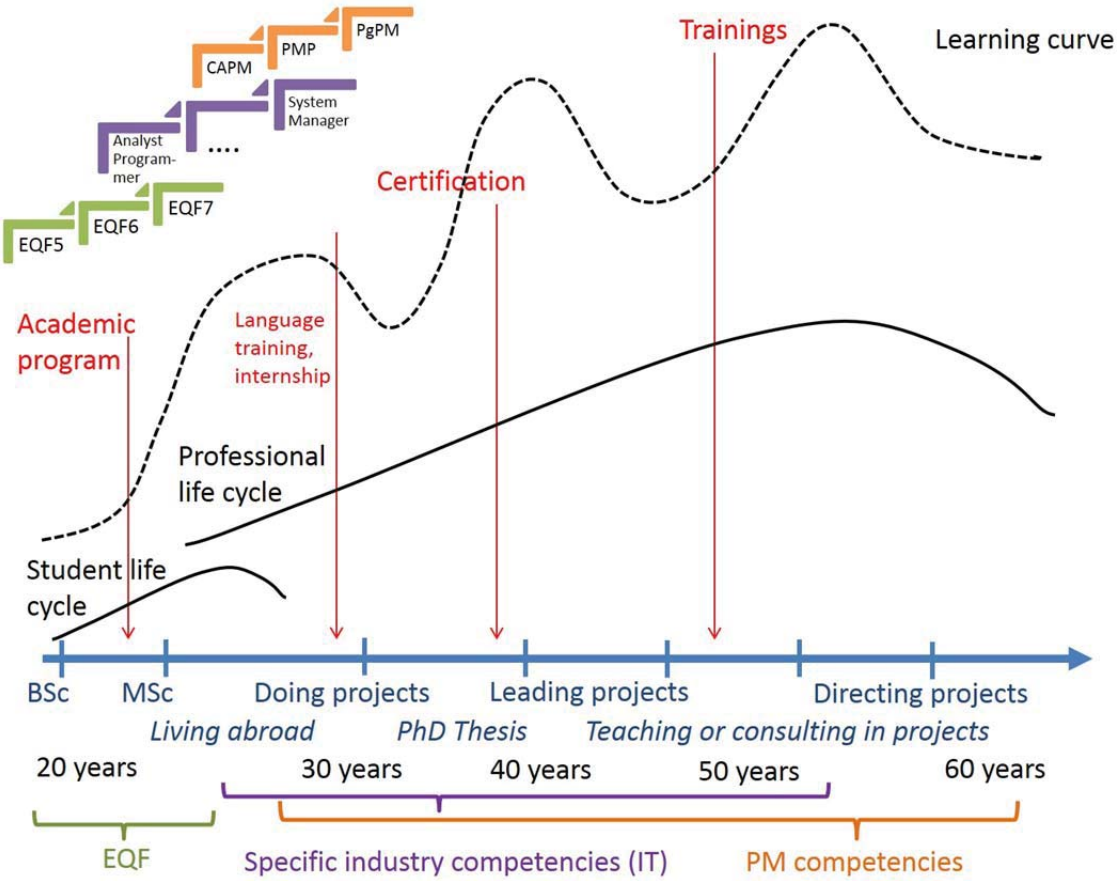

Fig. 1. Competency acquisition within an individual's life cycle [own source]

In other words, development of a project manager is an individual path of learning that can be represent via competency abstractions. This notion will be addressed further as 'competency development path".
A conceptual solution for a competency development path in PM is the subject of the study in order to be used as a tool that provides answers (at least) for the following questions:

- which competency elements an individual can study or exercise further;
- how the desirable competency elements connected with the present ones;
- which learning options and sources are available to master the desirable competency elements.

The competency development path solution should address the need of an individual to explore which competencies he or she should focus on, and/or which competences are to be developed. Moreover, it is relevant not only before but also after completion of a study course, a training, or a certification course. An interactive mapping solution should offer a means to plan an outcome-oriented learning, where the individual has an opportunity to set up most advanced competencies to be achieved, and thus, to build own development path through all possible means of learning: formal, non-formal, and informal. Moreover, it has to stimulate learning and development through reflection [6] and provide optimal range of choice and flexibility of entry and exit points for a project manager within the system [7].

Another important requirement is to give an overview of the links to the related spheres and practice taking into account industry-specific competencies (e.g., information systems, construction, engineering, pharmaceuticals). The interactive solution for the competency development path should be designed not only for representation but also for systematization of competencies related to PM. In other words, many PM competencies overlap with engineering, IT and other competencies. Such overlaps can be defined and described to build up an integrated competency development path.

The life cycle of a project manager is usually described by the roles played in a project. The possibility and necessity to create competency development path solution according to the roles played in a project is to be studied.

Another important aspect is to narrow the gap between what education providers are offering and what is needed to deal with projects in today's complex work environment [8].

To address the challenges mentioned above a meta-competency model may be required. Such a model can be created as an interactive tool to derive a tailored competency framework.

A meta-model may include (generic) competencies introduced in different kinds of standards, including the EQF and industry specific standards. Analyzing competence fields, defined according to the standards and different categories of learning, we may find some overlaps, gaps and also contradictions between them. It is a question, if harmonization can and should be done specifically for project management sphere, so that an individual (or an organization) could use such a pool for life-long learning and development in project management.

For example, let us consider the case of an individual as a project manager in the IT sphere. The area of competencies that allows to manage IT projects may include next fields/sets of competencies (see fig. 2):

- Academic competencies (which correspond to Master of Science in Project Management EQF Level 7 and Bachelor degree in computer science EQF Level 6)
- IT specific trainings (for example, in International Software Testing Qualifications Board (ISTQB®) that provides trainings and certification of competences in software testing)
- Experience in projects as a programmer in IT

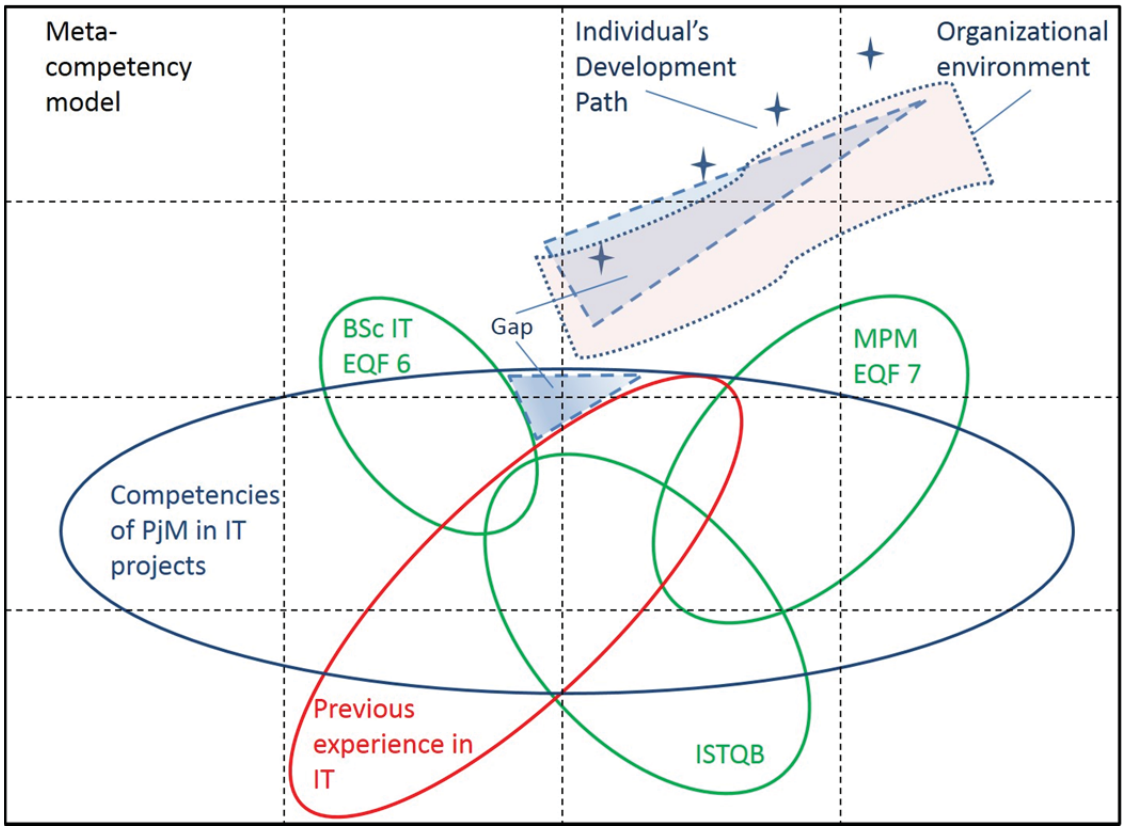

Fig. 2. Competency fields relevant for a project manager in IT sphere [own source]

The sets of competencies, acquired at different times and in different fields, can overlap. Sometimes a gap between competency fields may appear and change, as the area of the IT project manager competencies expands due to market demands and personal ambitions. In order to close this gap (see fig. 2), tools and methods are required. It can be, for example, as mentioned above, either a meta-model, which includes e.g. IT specific competencies, or a tailored competence model. In such a way either an individual, or an organization, can plan his or her development taking into account competencies acquired from different fields (see fig. 2). It is also important to align the development needs with the strategy and environment of the organization and/or the project team. Thus an individual's competency sets, or in another words, "competency profile", is shaped within different competencies fields, and personal and organizational goals.

In PM sphere competency-based approach is used by the leading professional bodies associated with PM "to address this issue of competence in a systematic manner" [9]. Standards relating to project management competency fall into two main areas: those relating to what project managers are expected to know, and those relating to what project managers are expected to be able to do [10]. Many project-oriented organizations require potential project management personnel to seek certification [2]. Different competency-based standards, such as ICB, PMCD, AIPM, offer competency-based certification process with different categorization and elaboration of competencies related to PM. In ICB these are "People", "Practice", and "Perspective" [11]. In PMCD offers such dimensions of competencies as "Knowledge", "Personal", and "Performance" [12].

These standards are a powerful tool and should be taken into account in order to develop a relevant meta-competency model. However, it is a question, if the categorization used in these standards is useful for the purpose of mapping competencies of an individual's development path. Many scholars and practitioners often categorize PM competencies as being 'hard' or 'soft'. Each PM standard has its own concept and approach to competency representation, so an

individual should look at his or her development through the specific frame of the particular standard. There is no a common approach to analyze competency-based standards from the point of view of an individual, who wants to plan his or her development according to his or her own needs and goals. Moreover, these standards have not specified the competencies required by an individual in each phase of a project, or in certain type of projects [13].

Turner and Müller report that "certification does have a positive effect on successful performance in project but only on highly complex projects, which are not the kinds of projects recently graduated students are likely to lead" [14]. On the other hand, there are always at least two certification systems to choose from; for example IPMA, PMI and APM are wide spread in Europe, IPMA and PMI in the post-Soviet countries. That is why it is important to provide options and links for learning competencies within or out of the frame of the main standards.

Another aspect of competency management is its application for empowerment and training as a part of human resource management of an organization. A conceptual solution should be useful to conduct such measures as following: identifying competency/learning gaps; developing learning schemes for improving the team performance in term of individual skills, team behavior and competencies; devising an evaluation system to assess the effectiveness and efficiency of training strategies; inspire and motivate to learn and lead [15].

Ramazani and Jergeas [8] conducted the qualitative study on project management and education resulted in the summary of educational considerations presented in the table 1.

Critical factors in developing project managers	**Educational considerations**
Developing skills for dealing with complexity • Adaptability • Critical thinking • Multidisciplinary • Collaborative skills	Educational models: Should incorporate complexity as an interpretive paradigm of thinking, Should have enough flexibility that will support and foster continuous change, creative and critical reflection, coping with uncertainty and complexities, Should develop comprehensive development which consider technical and people aspects of managing project and enable practitioners to select appropriate combinations of technical and interpersonal knowledge, Should foster critical thinking and responsible decision making, Should consider the multidisciplinary nature of project management including: cross discipline with other project managers, interdisciplinary with other leads and managers, and multidisciplinary with groups, Should reflect on learning content as well as the process of learning in different levels of their curriculum, Case studies, simulations' problem based learning and project based learning, role modeling, mentorship, and other active methods of teaching could facilitate this process.
Developing both interpersonal and technical skills • Technical skills • Planning, estimating/scheduling skills • Leadership • Interpersonal skills • Communication • Problem-solving skills • Team Working	Educational models should enable practitioners to select appropriate combinations of technical and interpersonal knowledge, practice and behaviors that will increase self-knowledge and the ability to build and contribute to high performance teams. Case studies, simulations' problem based learning and project based learning, role modeling, team working, mentorship and other active methods of teaching could facilitate this process.
Creating knowledge in the context of its application	Educational models: Should provide knowledge delivery in real contexts such as simulations and real case studies, Should consider learners (individually and collectively) as active agents in construction of knowledge, Reconstruction between theory and practice at different levels is necessary

	including: course planning, teaching, research. Cooperation between universities and industries provides a strong foundation for both management development and capability integration. Faculty members in project management should have practical experience to be able to adequately relate theory to practice.

Table 1. Practical considerations for educating and developing project managers [8]

These considerations are the valuable input into development of the conceptual solution. According to the literature analysis of many other sources the following considerations seem to be of more importance and, on the other hand, lacking scientific attention: having enough flexibility that will support and foster continuous change, creative and critical reflection; enabling practitioners to select appropriate combinations of technical and interpersonal knowledge; considering of the multidisciplinary nature of project management; reflecting on learning content as well as the process of learning in different levels of their curriculum; having simulations' problem based learning and project based learning; reconstruction between theory and practice; cooperation between universities and industries.

Many scholars suggest that there is a considerable work to be done to establish PM as a profession. There is a need for PM's formal representation to adopt a globally unified stance through the promotion of global cooperation and communication, the free sharing and exchange of ideas among members of the global PM community [16, p. 1401].

An important role in the development of project managers, according to Lorraine et al. [17], belongs to virtual communities of practice. Their research focused on such matters as: a) communities of practice as a possible mechanism for improving knowledge sharing among project managers; b) usage of various Web 2.0 technologies in PM communities of practices. The results of the study show that the most popular tools used for assisting in personal, professional, and communities of practice objectives were LinkedIn and webinars, along with Facebook, used for achieving personal objectives. In contrast to formal work groups or project teams where the employees are assigned by management, members of a community of practice select and organize themselves.

Besides that the study presents valuable findings on what motivates a project manager to participate in a community of practice.

It is necessary to take into account such aspects and forms of virtual interaction to understand the needs of professionals. The features of Web 2.0 technologies maybe embedded in the conceptual interactive solution for a competency development path.

3. Interactive solutions for competency management in PM

Based on the trends and requirements mentioned above the state of the art regarding conceptual solutions has been performed.

Competency models has become a mainstream practice in human resource management [18], the science, which deals with recruitment, disposition and development, leadership, retention, and release of PM personnel [2]. "A competency model is a framework for organizing a collection of observable skills, behaviors, and attitudes that impact the quality of work that people do. It describes what people need to know and be able to do in order to execute on their responsibilities effectively" [19]. In the models, competencies are typically organized into a hierarchy or grouped into clusters with descriptors. Generally, the competency model for a single role would be likely to have eight to sixteen competencies [20].

Let us consider an example how project management competencies can be represented and linked with engineering competencies. The Project Management and Systems Engineering Competency Model was developed by the Academy of Program/Project & Engineering Leadership (APPEL) [21] to support the professional development of NASA's technical workforce (see fig. 3). The aim of the model is to represent distinct competency areas for

project managers and systems engineers, as well as shared competencies that encompass both disciplines. There are 18 separate project management competencies and 17 systems engineering competencies, which are categorized into 3 overall areas. The 14 shared competencies, common to both project management and systems engineers, are categorized into 5 general areas. The model demonstrates one of the possible visualizations for an individual's development path.

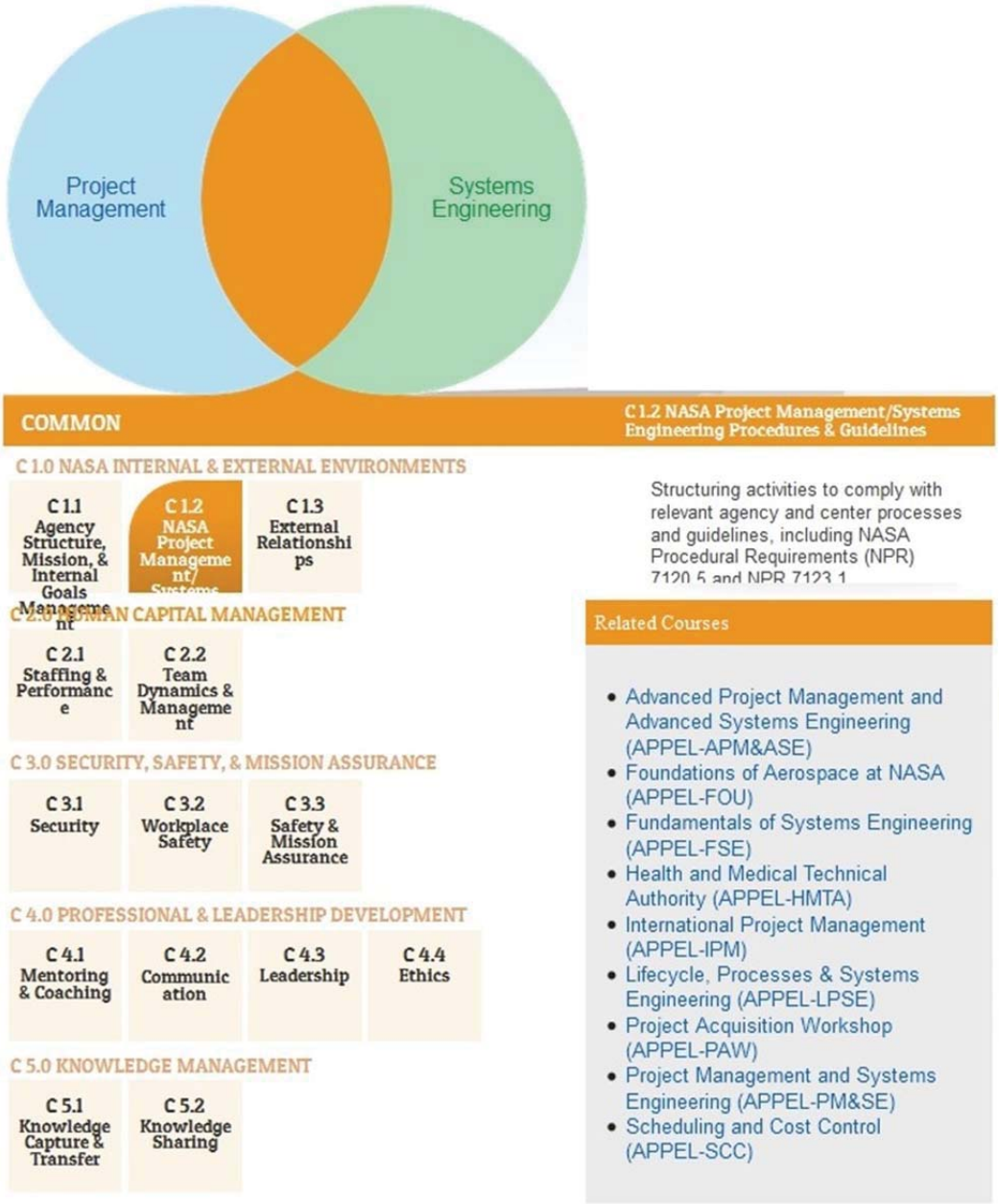

Fig. 3. The project management and systems engineering competency model [21]

Another valuable development on competency management is performed by the Petroleum and Chemical Industry Committee (PCIC) in an international oil company (IOC) [22]. Within the frame of their study the following elements of desirable competency management are suggested:

- a reasonable mapping of the different job roles and the competencies required by these;

- a way to assess how new developing engineers or experienced hires match against these competence requirements;
- the assurance that decisions relating to process safety are made by persons with the correct authority;
- programs available to address any gaps in competence;
- a means to do all the aforementioned in a consistent way across the globe.

Though in this study it is stated that such overlaying multidiscipline competencies as commercial and project management are outside of its scope, there are useful findings worth mentioning. The aim of the study is to create a competence framework that can be applied in all countries where the IOC operates to develop young engineers into value adding business-relevant employees using a similar standard in an effective timeline. The principal components of such an approach are as follows:

- clear and precise definitions of competencies that an engineer must gain in the program;
- a process to carry out assessment to verify that an engineer has gained the required competencies;
- learning programs in support of the acquisition of the new knowledge related to the desired competencies;
- a structured program of job tasks aligned to the competence definitions;
- competence can be only gained through the application of knowledge in a work-related environment, i.e., practical experience;
- a means to manage and monitor that all discipline programs are progressing in a consistent way;
- an opportunity for advancement upon the successful completion of the program and consequence management where there is underperformance.

At present PCIC Europe based on components mentioned above is developing a competence map with a dedicated solution in the form of a designed-for-purpose website with specific access and deliverables. The competence map is supposed to be described block by block with links to the available materials. The key performance of such a website would be the ability to quickly and easily identify related materials.

Takey and Carvalho presented a seven-step method for the project management competency map developed by an action research in a large Brazilian engineering company [23]. Among other interesting findings of this research there is a relational map designed based on top management trajectories and PMO members' trajectories, which links competencies and project experience. Maps were drawn with the software C-map® relating the interviewees' experiences and the PM competencies developed. C-map® is a software designed to construct, navigate, share and criticize knowledge models represented as concept maps [24].

4. Results and Conclusion

In an environment where individuals change their life, learning and work roles, it is necessary to design and manage their careers. Competencies acquired by an individual through the academic education, according to professional standards and within different technical domains or industries need to be integrated to facilitate and ensure purposeful career management.

Meta-competency model may address the need to provide the optimal range of choice and flexibility of entry and exit points for a project manager within the system. Scholars study and analyze different career models, but there is a little focus on sustainable perspective in learning PM and on creation of interactive meta-competency solutions.

The state of the art shows that existing competency models contain competencies relevant for a specific organization, an industry, or a project role. There is no interactive solution based on a meta-competency model which would contain all existing competencies relevant for PM. Nevertheless, available competency models should be studied in terms of principles of hierarchy, categorization, evaluation and links between interdisciplinary competencies. One of

the most common feature of studies connected with competency development and mapping is a close cooperation between stakeholders: practitioners, employers, and researchers that produces a sense of ownership of results.

A comprehensive picture of possible career paths – in terms of the required competencies and learning options – can help individuals to plan and accomplish sustainable learning at best. Tools for learning in PM should be developed in respect with the following requirements and trends:

- Allow to plan learning outcomes
- Show flexible paths to acquire competencies
- Combine PM specific, interdisciplinary and industry-specific competencies
- Take into account professional certification systems as part of competency development
- Narrow the gap between theory and practice
- Display development in terms of project roles where it is applicable
- Facilitate virtual learning and interaction involving all stakeholders.

Competency abstractions have to be studied as a means for a conceptual solution for competency management in PM. Advantages and feasibility of a competency-based interactive solution need further investigations.

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Aspects of Higher Education Projects in Palestine within the European Framework Programmes for Education, Youth and Training

***Suhail Barakeh, Ala Nuseibah*[1]**

suhailbarakeh@gmail.com, Birzeit University, Ramallah, Palestine
ala.nuseibah@fh-dortmund.de, Dortmund University of Applied Sciences & Arts
Otto-Hahn-Str. 23, 44227 Germany

Abstract

With the emergence of the Palestinian economy and the increasing international recognition of the State of Palestine, it becomes more and more rewarding for local and international companies to seek partnerships, benefit from the potential of the young population and invest in Palestine. Tourism, agriculture and small industries used to be the main contributors to the Palestinian GDP in the past. However, political challenges over the last few decades led to the shrinking of these sectors. This makes the investment into the human capital more important and essential for the creation of value to the economy and community. [1]
However, the deficit in the government's budget creates deficits in the budgets of the different types of Higher Education Institutions (HEIs) in Palestine, with only 6% of the total higher education budget dedicated to non-operational, development goals [1] [2] [3]. The European Union with its Framework Programmes for Education, Youth and Training is the major provider of financial aid to the Palestinian Higher Education System.
This paper will discuss the reality and challenges facing development and capacity building projects at HEIs and ways to overcome them based on publications of the European Commission and the local governmental bodies in Palestine. The paper also includes an example of a successful project. This example is provided based on interviews conducted with the Palestinian project team. Both authors of this paper are or have been affiliated with HEIs in Palestine.

Keywords: Higher Education, Erasmus+, Palestine

1. Overview of Higher Education in Palestine

Palestine has its special case as a developing country, due to the decades of political instability and occupation. Palestine is one of the rare cases of the world of a country with no access to its own natural resources on over 60% of its grounds and waters [4] [5] [6]. With a population of 4.75 million at the end of 2015 [7], one third of it being in the youth category, over 60% of which are between the ages of 20 – 29, [8] the human resource, and particularly youth, is the best available resource for advancing the country's economy. Higher education is the best way to access and develop this age category.

[1] Corresponding author

According to the Palestinian Law of Higher Education, HEIs include:

1. Universities which are “institutions consisting of no less than three colleges or faculties provide bachelor degrees or higher”
2. University colleges which are “institutions that offer academic, technical, or professional programmes and award two or three year’s diplomas or bachelor degrees”
3. Polytechnics which are “institutions that provide diplomas or bachelor degrees and higher degrees in professional and technical fields only”
4. Community colleges which are “institutions that offer professional or technical programs of a minimum of one year diplomas” [9]

As for the governing bodies of those HEIs, these fall under four categories:

1. Governmental: run and financed by the Palestinian government. 11 institutions fall under this category.
2. Public: These are non-profit universities, and originally created and owned by local charity associations and NGOs. The reason behind this type is that higher education institutions (universities) were set up mostly during the period of Israeli occupation of the West Bank and the Gaza Strip and before the set-up of the Palestinian National Authority (in 1993, later Palestinian Government). Nowadays, they depend on fundraising, own revenue structures and receive partial government funding. 17 institutions fall under this category.
3. Private: these institutions are run and financed by foundations, charitable societies, religious denominations, individuals and companies. 17 institutions fall under this category.
4. UNRWA: operated and financed by the United Nations Relief and Works Agency for the Refugees of the occupied Palestinian Territories (UNRWA). Here the focus in HE is mainly on technical and vocational training. 4 institutions fall under this category. [2] [3] [9]

In the following table, quick facts about the status of the Higher Education in Palestine are available:

Total number of HEIs	49
Total government spending on education (total)	2 – 3%.
number of enrolled students in HEIs	221,395
Which constitute … of total Palestinian youth (18-24 years old)	36.9%
Percentage of male youth (18-24 years) enrolled in an HEI	32.1%
Percentage of female youth (18-24 years) enrolled in an HEI	42.0%
Oldest HEI is … years old	45

Table 1: Quick Facts about Higher Education in Palestine (compiled by authors) [1] [3] [10] [11]

Compared to neighbouring Middle-Eastern countries, the enrolment rate in HEIs among age group of 18-24 years old is significantly high despite the political and geographic setbacks [2]. This is an indicator of the significance of higher education for the Palestinian people. However, a deeper look into the financial situation facing HEIs reveals more complications. The type of

body governing the HEI governs its access to funds and its ability to develop, especially that government spending is insufficient for HEIs. A significant part of HEI funding is based on internal revenues created by the business model (if applicable). Between 65-70% of the operating budgets of higher education institutions is covered by tuition fees [2] [3] [10]. This results in frequent raises in tuition fees, especially at universities, to cover costs. This means less accessibility to higher education for the less privileged classes of the society, which resulted in drop-outs over the last years. Reflecting on the enrolment rate mentioned above and taking this knowledge into consideration could mean that the rate could be even higher with a more appropriate financial leverage to HEIs.

Recent reports from the Palestinian Ministry of Education & Higher Education show that it aims to empower HEIs and support their administrative financial budget [12]. Despite the irregularity of revenue from tuition fees and the deficit in the budgets of HEIs, with the support of the government and private donations, they are able to afford the costs of their routine operations. However, this means that any activity that does not fall into the direct educational activities of an HEI or that require significant funding, either for development or set-up of joint work with partners would rely on external aid. [1] [2] [3]

2. Higher Education Projects in Palestine

The reasons above make HEIs in Palestine very dependable on foreign donors' aid for development & internationalization projects. Projects are therefore subject to externally-defined goals, rules and conditions. Moreover, higher education institutions have to follow certain criteria in order to be eligible to implement such projects. EU funds the major number of ongoing projects in the Palestinian HEIs [13], mainly through the former Tempus (starting 2002), Erasmus Mundus and currently Erasmus+ Programme (the framework programme 2014 – 2020 combining all the EU's current schemes for education, training, youth and sport, including the former programmes). [14]

For any project at a Palestinian HEI to be funded by EU, it should meet three main requirements [2]. First, is to ensure that the cooperation between the HEIs in Palestine and the European partners leads to sustainable development and balanced outcome for all parties involved. This requires the institutions to participate in a proactive way by establishing the objectives and justifications for its participation based on a specific need analysis. Moreover, the expected result in any participation should be sustainable and lead to future development, taking into consideration the priorities in the specific subject fields and geographical interests. Second, what EU partners need to be assured from the participating HEI is to provide relevant support to staff and students during the project by allocating resources and providing administrative backup and tools. Third, any participating HEI should exploit the results of the project to maximize the impact of the project on individuals and participating institutions. [14]

Among the four types of HEIs in Palestine, universities (despite differences among them) are on the top level of development and modernity in facilities, infrastructure and skill-sets. Therefore, they offer the best readiness level to Erasmus+ projects. However, they still face several challenges which include:

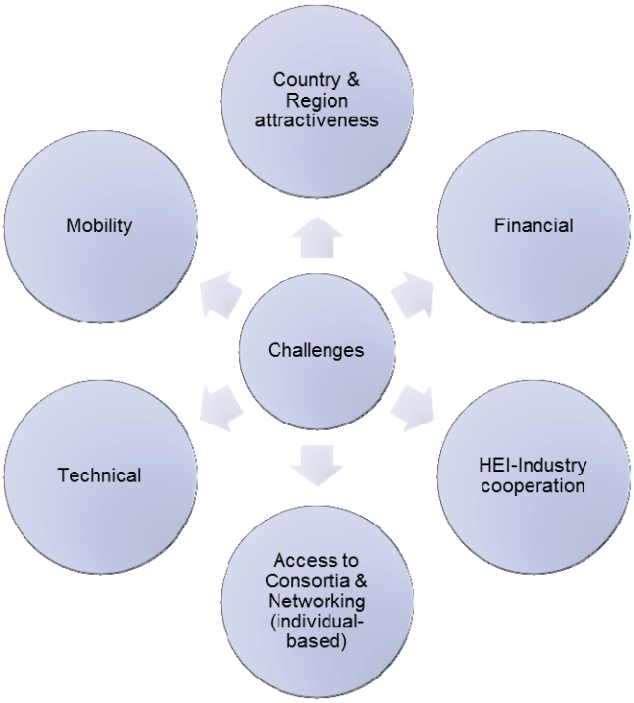

Figure 1: Challenges Palestinian universities face to receive EU-funding for HE projects within the Eramus+ Framework Programme (own drawing)

1. Country & Region-attractiveness
2. Financial challenges
3. University-Industry cooperation
4. Networking and Access to Consortia
5. Technical challenges
6. Mobility

These challenges will be discussed thoroughly in the light of the example project in the next section.

3. An Example Project – The Development of a Master's Study Programme in Software Engineering at Birzeit University

One of the leading higher education institutions in Palestine is Birzeit University. According to the latest QS university ranking, Birzeit University is the first in Palestine and one of the best in the Arab Region [15] [16]. This ranking is based on the ratio of teachers to students, ratio of Doctorate degree holders to teaching staff, ratio of published articles per member of the academic staff, ratio of citations per paper, ratio of international students, ratio of international academic staff, academic reputation and web impact.

Birzeit is also the leading Palestinian university in participation within the EU Framework Programmes Tempus, Erasmus Mundus and Erasmus+. This information is based on an

assessment of the number of proposals that were granted funding throughout the different years and/ or programmes:

- 2000-2006: 6 grants
- 2008-2012: 8 grants (3 of which BZU was the project coordinator)
- 2013-2014: 5 grants
- 2014-2015: 2 grants (1 of which BZU was the project coordinator)
- 2015-2016: 6 grants [3] [17]

One of those successful projects implemented in Birzeit University is the project to develop a joint master in software engineering.

One of the most promising sectors in the Palestinian economy is the ICT sector. It is the fastest growing among Palestinian economic sectors with an annual growth rate of more than 10% and an 8% contribution to the Palestinian Gross Domestic Product (GDP) [18]. Therefore, it is crucial for the economy that the ICT sector keeps up with international trends. This master's in software engineering is first of its kind in the Middle East and aimed to fill the gap between academia and industry in the ICT sector, especially that the most prevalent type of ICT companies in Palestine are software companies. [18]

The project objectives were

- to develop and implement the total of 12 modules in Software Engineering in partner country universities using e-learning modules for teaching with the supervision and support of the EU programme countries
- to develop and implement a Master's Programme in Software Engineering jointly taught by universities in each partner country
- to promote the adoption of the Bologna system
- to improve the human capacity of partner country universities by providing research collaboration opportunities with EU staff members through joint thesis supervision.

The project was granted funding in 2012. The consortium consisted of four European universities from Germany (University of Koblenz · Landau), Italy (Free University of Bozen – Bolzano), Greece (Harokopio University) and Britain (Middlesex University)m three Palestinian universities: Birzeit university (as project coordinator) in addition to Al-Quds University and the Islamic University in Gaza, plus three Egyptian universities namely Egyptian e-Learning University, Cairo University, and Helwan University.

As mentioned in the previous section, such projects face a number of challenges when implemented in Palestine. This project was no exception. However, to make the project successful, there were solutions and work-arounds for the different types of the challenges as will be discussed next.

For a country that suffers from constant political instability, Palestine faces difficulties in attracting international academic staff and students to participate in exchanges and longer term stays. This has aggravated by the political instability of the whole region following the Arab Spring, which also reflected on the foreign aid dedicated to Palestine as a developing country in

the Middle East. This creates a direct challenge to Palestinian universities to access consortia and to build networks and partnerships on university-level. However, with motivated and dedicated staff with individuals who have worked and travelled abroad, this consortium was set-up through individual contacts in a way that balances out the needs and completes the value chain in order to deliver the required modules.

The financial challenges facing HEIs in Palestine has been extensively discussed in the previous section of the paper. As this project was funded by the European Commission (EC), the challenge of financing it was overcome. In addition, the financial and procurement processes at Birzeit University follow the rules of integrity, efficiency and transparency that facilitate financial management and reporting to the EC. This was considered a competitive advantage for Birzeit University that allowed it to coordinate the project. The technical challenges were also overcome through the objectives of the project, because it was planned to equip HEIs with the necessary labs and equipment to be able to teach modules on software engineering through project funding. The technical challenge however is not limited to equipment; it also includes the technical know-how in the field and the processes, tools and experience available at the university to apply for EU-funded projects. Birzeit University had an advantage in this regard in comparison to its partners in the Middle East. However, the gap between the project management and the strategic management levels at the university and the centralization of the application process are issues that need to be solved; in addition to the amount of bureaucracy involved in receiving accreditation for the study programmes. Nevertheless, the Master of Software Engineering was successfully accredited by the Palestinian Ministry of Education & Higher Education in 2013. [19]

As this project is oriented towards creating modules to teach software engineering, the involvement of local ICT companies to define their needs and to participate in the creation of the modules was necessary. The closer cooperation between universities and industry, especially in the ICT sector, was also considered a national priority by the Palestinian government. However, this is not very typical for traditional universities in Palestine and the university system does not offer structures that support the university-industry interaction. Large and small and medium-sized ICT companies in Palestine are represented under an umbrella association called “PITA - Palestinian Information Technology Association”. Through initiation of the project manager and responsiveness of PITA, this challenge was overcome and they implemented a phase of market and needs analysis and later cooperated in the development of curricula modules. [19]

The last challenge is mobility, which relates largely to the physical barriers and checkpoints separating Palestinian cities from one another. As a work-around to this problem, the project was based on the concept of “training the trainers” – organizing trainings for the Palestinian and Egyptian academic staff at the European partners, so they can then return to their countries and universities and implement their own customized modules, while keeping in contact with the other partner through e-meetings. In addition to this, the total blockade imposed on the Gaza Strip since 2007 did not only pose a challenge to the mobility of the project staff and students in Gaza from attending the trainings that took place in Palestine and abroad, it also prevented the import of equipment to this particular university. The situation with the Islamic University in Gaza as a partner in the project deteriorated further because of the two wars launched against

the Gaza Strip during the project duration in 2012 and 2014. Therefore, it was decided to rely more heavily on electronic means of participation in the project and e-modules as content for teaching and learning for the partner in Gaza.

Despite the challenges and with the determination to make the project successful, a total of 12 modules in Software Engineering were developed and implemented (80% physical, 20% e-learning). The first batch of students enrolled in the Winter Semester of 2014/2015. The project partners in the EU and the Middle East also agreed to extend their cooperation to research through joint thesis supervision. [19]

5. Reflections and Further Research

Investment in education enriches the human capital, and allows for development and innovation of any state, especially in the case of developing countries. Despite challenges and due to the human potential and demand for international cooperation, Palestine has moved forward in advancing and investing in its human capital, with the help of foreign aid and EU-funding.

The study was conducted on a small-scale, based on available literature and interviews with staff. Comparative studies about such projects with countries facing similar challenges would be interesting to identify solutions and work-arounds for the higher educational system. In addition, taking more projects, more universities and/or longer time-frames into consideration can result in an improvement to the assumptions and results.

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Internationalisation of Academia – A study about the Internationalisation of human resources of Dortmund University of Applied Sciences and Arts

Caroline Quester

Human Resources Department
caroline.quester@fh-dortmund.de
Dortmund University of Applied Sciences and Arts,
Sonnenstraße 96-100, 44137 Dortmund, Germany

Keywords: Internationalisation of Higher Education Institutes, Internationalisation of human resources, International Activities, Survey

Abstract: Internationalisation of Higher Education Institutes has become more and more important and also dynamic for universities in the last decades. Due to a high competition amongst universities, internationalisation has become a mandatory task for HEI. But it´s not any longer only about the exchange of students and lecturers, it´s also about the internationalisation of the personnel. That means the need of making the staff, with their skills and qualifications, international.

1. Introduction

Increasing globalisation, internationalisation and Europeanisation and the growing international competition demand a stronger international orientation of universities [1]. In addition to the competition amongst the Federal States as well as individual universities, competitive forms of internationalisation include a competition about subsidies, reputation, excellent students, lecturers and scientists [2]. Therefore internationalisation has become a central profile feature for academia.

In the foreground of internationalisation of HEI is the international education of the students who have to present themselves as skilled workers for international operating companies on a global job market. It´s about the purpose to expand their horizon of experience by international input as well as about the qualitative improvement and upgrading of the studies. It is also about the sensitisation in dealing with people from different countries and cultures. In the field of research the focus is on international co-operations and collaborations with other scientists and their professional exchange of their scientific knowledge and also the transfer of research findings and scientific discoveries.

Meanwhile internationalisation plays a major role in the higher education policy. But so far the view regarding internationalisation in the field of academia is limited to the fields studies, teaching and research, less attention receives the field personnel, that is the scientific and non-scientific staff, which assume the service functions of the universities and form the environment, in which the student´s education takes place.

The aim of this paper is to give an overview about the current state of the internationality of the employees of Dortmund University of Applied Sciences and Arts and to emphasise the importance of the internationalisation of human resources for the internationalisation of academia.

2. Internationalisation of Academia

The issue internationalisation has become an important trend in the field of higher education [3]. Meanwhile there is a huge number of Europe- and nationwide support programmes relating to strengthen the internationalisation of HEIs. With the Bologna Reform European countries aimed the creation of an European Higher Education Area (EHEA), in which the international competitiveness of European HEIs is supported and comparability of study degrees allowed. In addition to that and also a long time before the establishment of the Bologna Reform there have been many other mobility and higher education cooperation programmes, which also have the aim to increase the collaboration between European universities and to create an unified European university system.

In this sense it´s not any longer only the realisation of individual international measures like the exchange of students and lecturers, it´s more about the development from an addition of international activities towards internationalisation as a strategy [4].

> „Internationalisation of higher education is the process of integrating an international/intercultural dimension into the teaching, research and service functions of the institution [5]."

Individual international activities, e.g. the exchange of students, lecturers and staff, the establishment of international study courses and curriculums as well as individual transnational research co-operations and the resulting cross border transfer of knowledge, should be summarised to a common strategy. Internationalisation should become a culture at university and international aspects should be found in the everyday life at a university and cover all its areas. Thus, international aspects get part of the university´s self-image and are made visible inside and outside.

As already mentioned, internationalisation does not only affect the areas study, education and research, but also human resources. Even if the personnel is not directly associated with the core task of HEIs, the knowledge generation and the knowledge transfer, it is an important pillar of the universities and does form the frame, in which the students are educated in an international way and for a global job market. Furthermore the education is also concerned to international students. Therefore it´s necessary that international aspects and experiences, skills and competences of the staff find their way in every structure and in the norms and values of each university.

3. Visualisation of the current State of the Internationality of the personnel

3.1 Methodical Approach

The Data were collected with a study in the form of a survey, which was conducted in the form of a standardised online questionnaire. The aim of this survey was to collect as much information as possible about the international experiences, skills and competences of the employees and to determine the current status of the internationality of the staff from the results.

Therefore the survey contained almost 30 questions which deal with the above-named personal qualities as well as with the information and communication about the internationalisation within the university and the resulting consequences for the employees.

The entire academic and non-academic personnel of Dortmund University of Applied Sciences and Arts were questioned within the survey, in total 407 persons. Professors, lecturers and other persons regarding to teaching didn´t belong to the target group. Of this population of 407 people one third answered the online questionnaire completely. These ones were included in the evaluation [6].

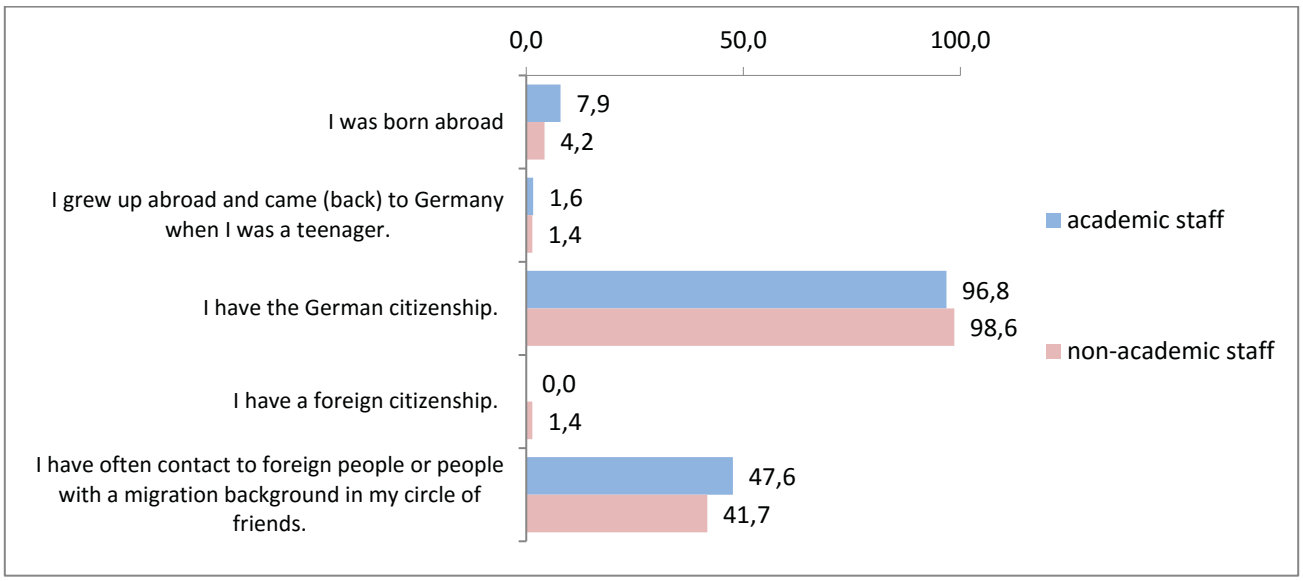
Within the survey the target group was divided into male and female and academic and non-academic staff. This classification should be used for a better analysis regarding the different interests and requirements related to international aspects for academic and non-academic staff.

The data were analysed by means of a significance test, the Chi-Square test, to find out, if two analysed features are independent of each other or if they are in connection with each other. Here is an example: a question within the survey was, if the employees do know the internationalisation strategy of Dortmund University of Applied Sciences and Arts. In this case with the help of the Chi-Square test could be analysed, if the knowledge of the strategy is independent of the sex or of the belonging to a status group [6]. With these statistical evaluations and the knowledge of significant relationships between the features special needs for the different kinds of staff can be emphasised and measures can be derived to resolve the lack of internationalisation of human resources.

3.2 Selected Survey Results

The following lists a few selected results of the survey and of the analysis, which help to represent the status of the internationality of the employees. In several cases the results were analysed in two categories: the status groups “academic” and “non-academic staff”.

The figures below show, how many employees do have an international background, divided in academic and non-academic staff:

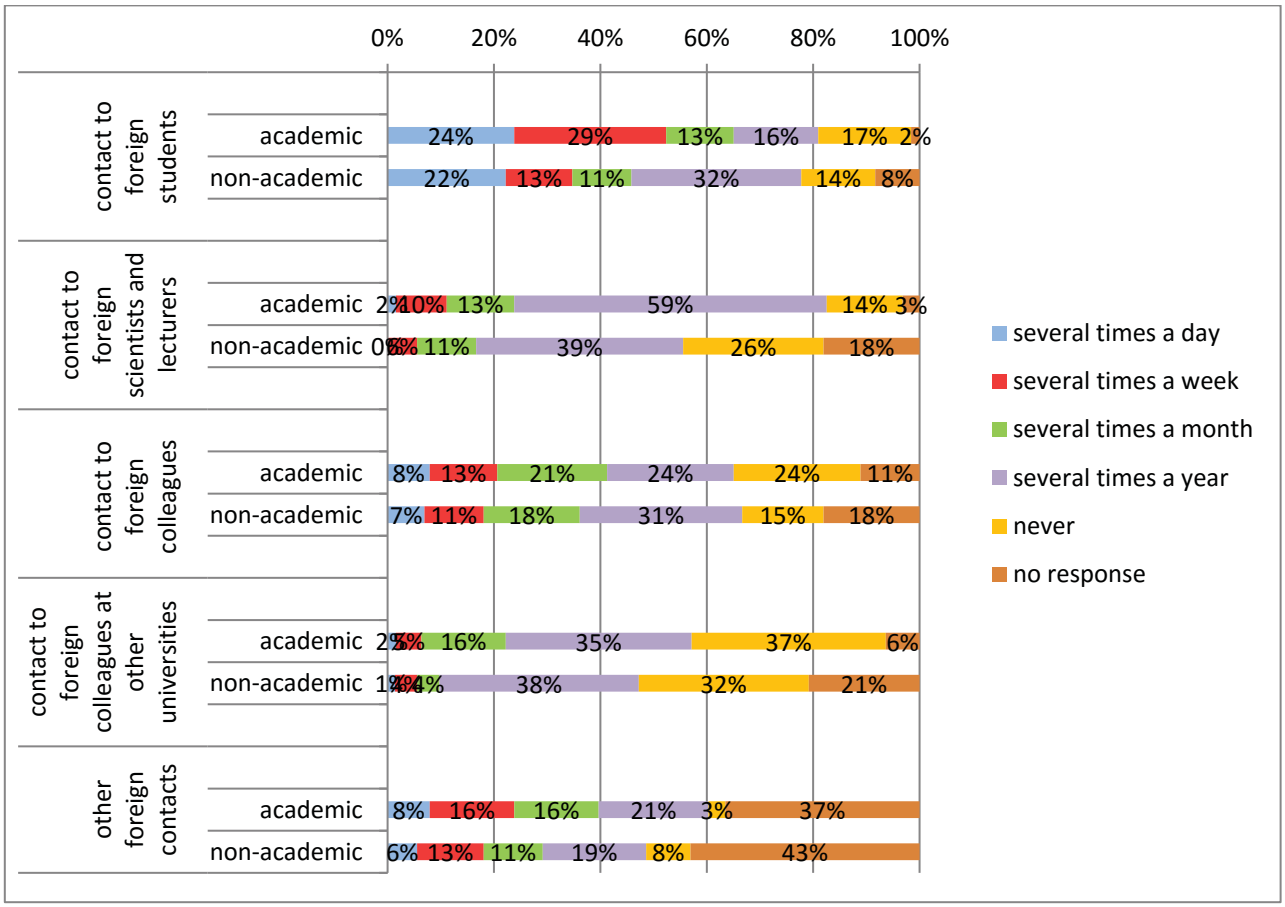


(source: own research)

Figure 1: personal origin depending on status group (figures in per cent)

According to the survey only 4% respectively 8% of the (non-)academic staff was born abroad. Less than 2% grew up abroad and just about one percent has a foreign nationality.

The next diagram displays the results regarding the contact to foreign people within the daily work:

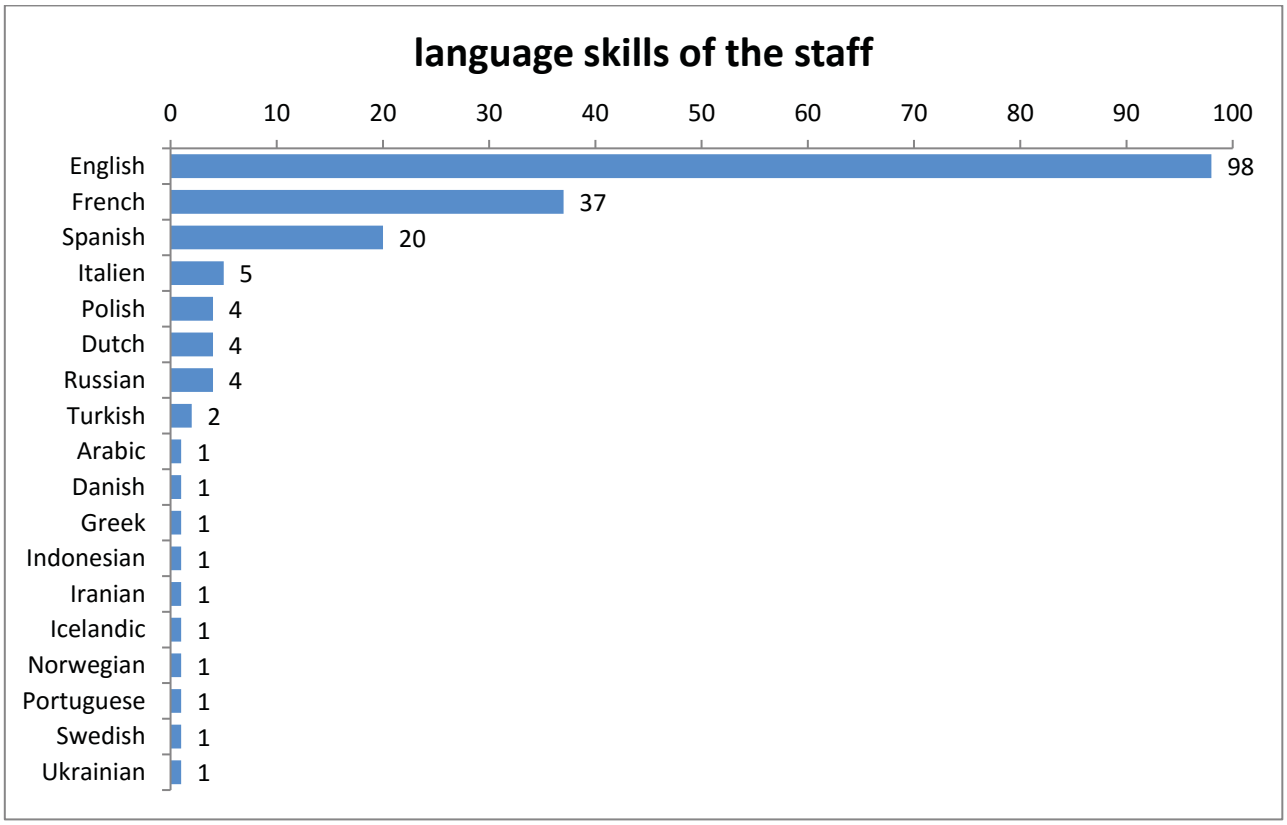


(source: own research)

Figure 2: contact to foreign people within the daily work (figures in per cent)

The employees were asked if they have contact to foreign people (students, scientists, colleagues, external persons) within their daily work and to estimate how often they have this contact on a scale from “several times a day” to “never”. The most commonly contact they do have, both academic and non-academic staff, is to foreign students, up to several times a day (24% / 22%) or a week (29% / 13%). They have less contact to foreign scientists, colleagues or external foreign people.

Another set of questions dealt with the language skills of the employees. Requested were information about the languages they are able to speak, which level of knowledge they have and how often they have to use their language skills within their daily work. The following figures show the results.
The first diagram represents, which languages the employees mentioned within the question, which language they are able to speak (regardless of the level of knowledge):

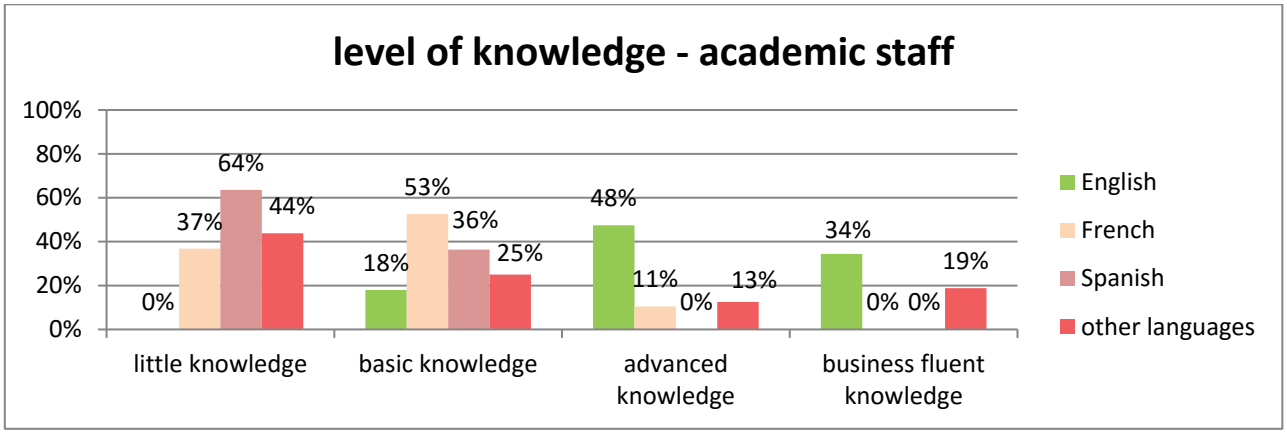


(source: own research)

Figure 3: language skills of the staff (figures in per cent)

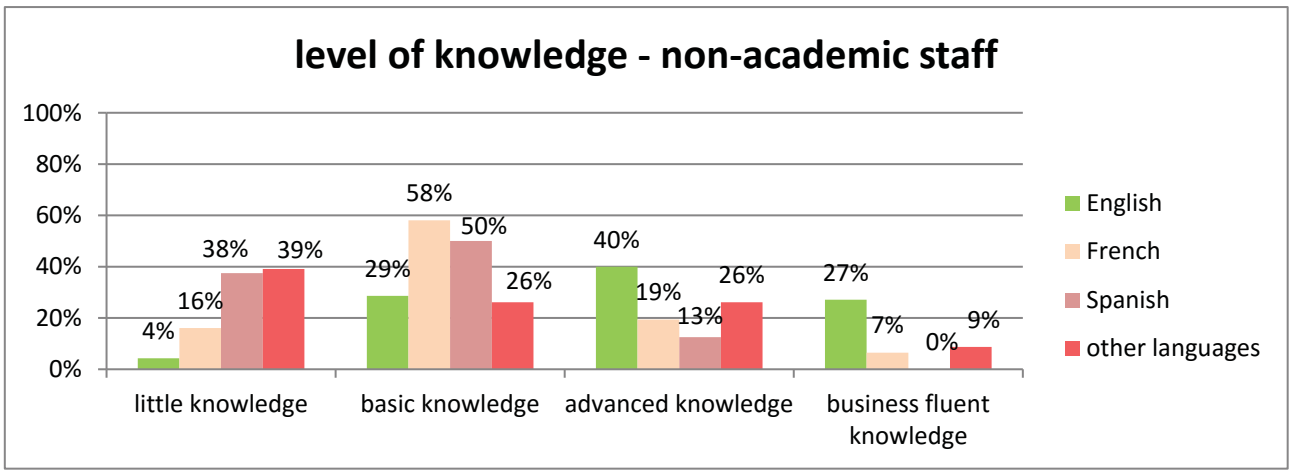
The most common language they are able to speak is the English language. According to the results 98% speak English. The French language comes second with 37% and Spanish comes third with 20%. The other listed languages were only mentioned by very few, mostly just one person.

The following two figures provide an overview of the level of knowledge of the language skills of the employees, who estimated themselves:



(source: own research)

Figure 4: level of knowledge of the language skills of the academic staff (figures in per cent)

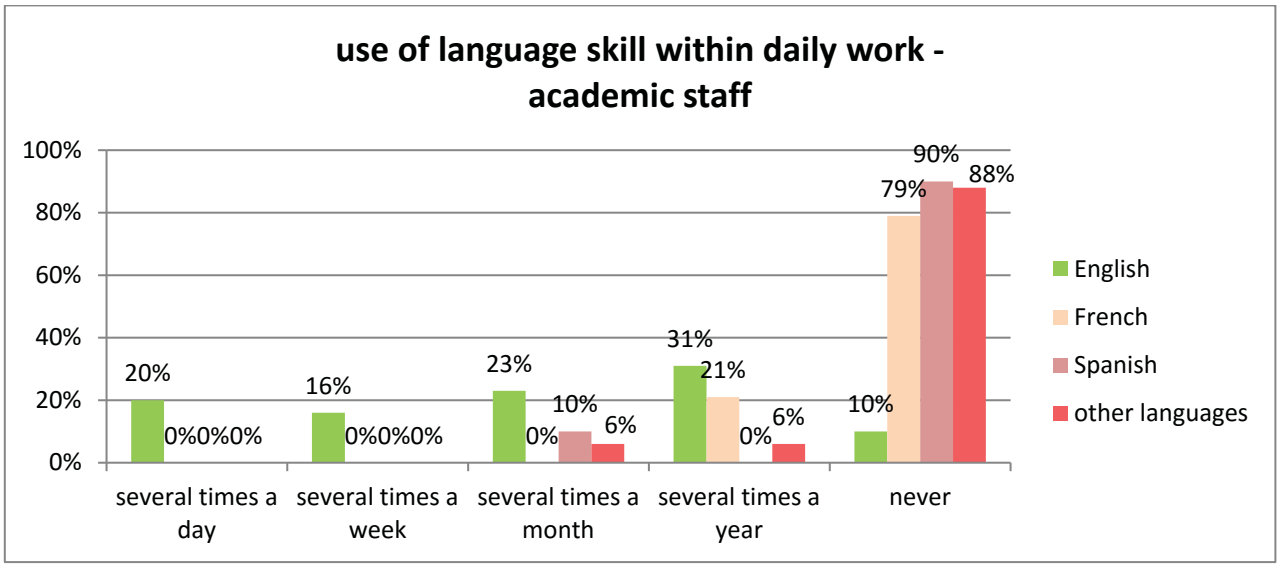


(source: own research)

Figure 5: level of knowledge of the language skills of the non-academic staff (figures in per cent)

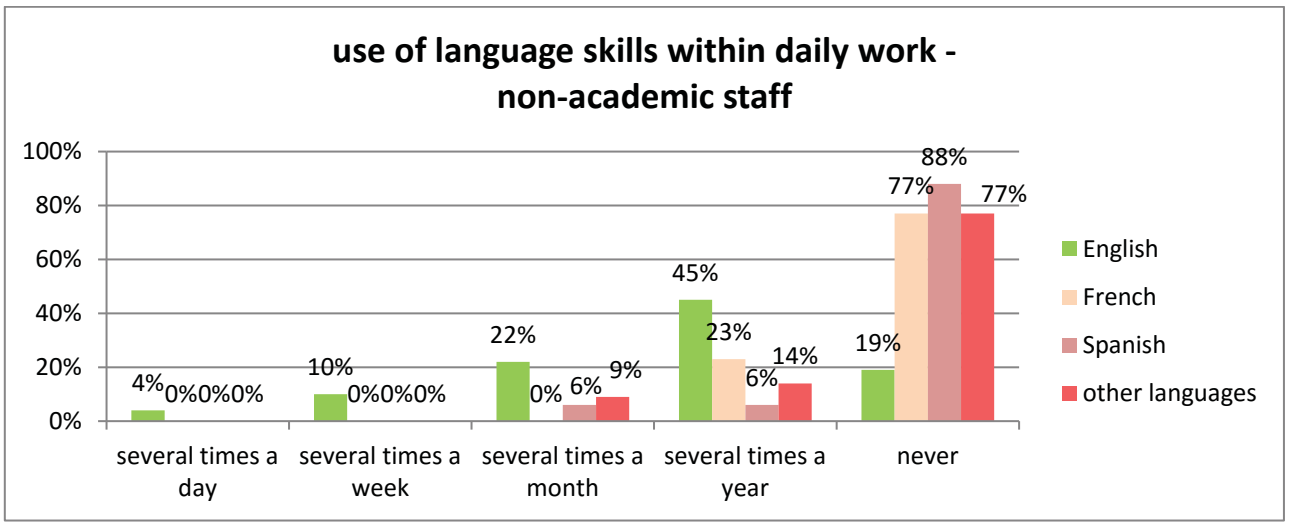
The interviewed persons had to estimate their level of knowledge on a scale of "little knowledge" to "business fluent". The results of both status groups are quite similar. It is conspicuous that English is the language in which most of the employees have the best knowledge, while they estimated their skills for the French and Spanish language predominant with little or basic knowledge.
The other listed languages from figure 3 were summarised in the category "other languages". Here the respondents also estimated their skills predominant with little or basic knowledge, while, in contrast to French and Spanish, more persons also have advanced and business fluent knowledge.

According to estimations of all interviewed persons within the survey, the next two figures show how often the academic and non-academic staff has to use their language skills within their daily work:



(source: own research)

Figure 6: use of the language skills of the academic staff within the daily work (figures in per cent)

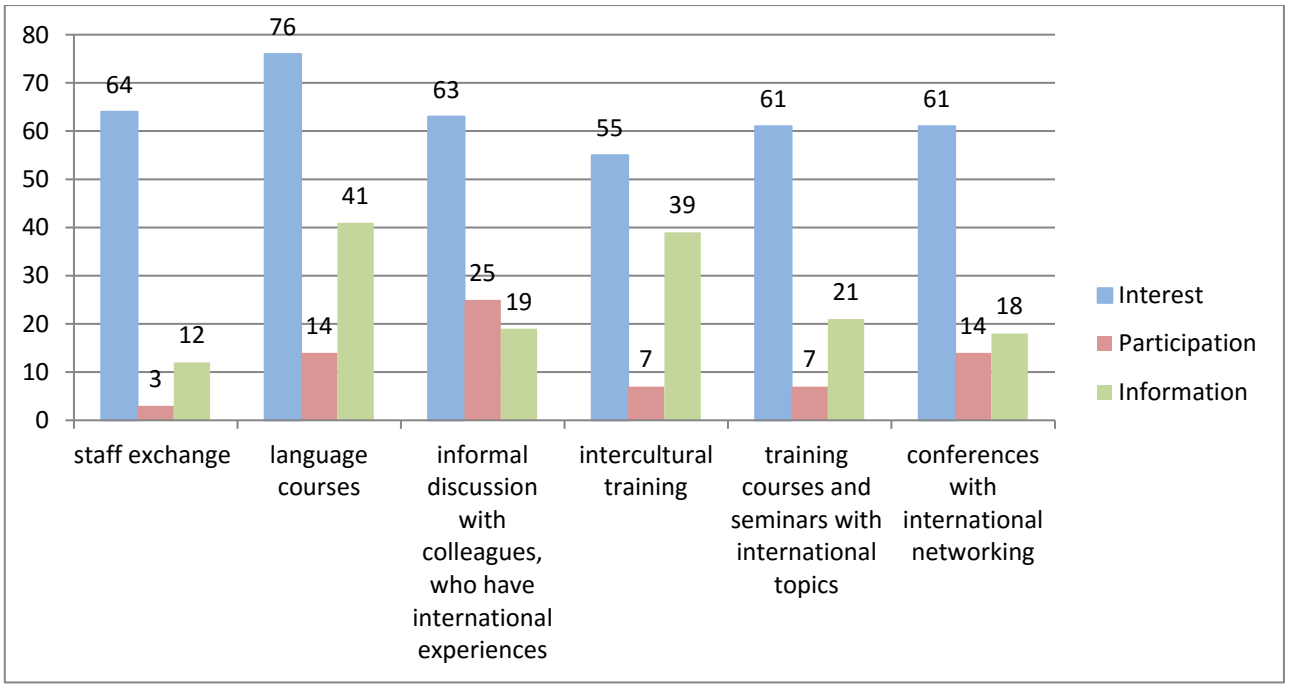


(source: own research)

Figure 7: use of the language skills of the non-academic staff within the daily work (figures in per cent)

The same as with the question before, here are no major differences concerning the responses with regard to the two status groups. The results show, that here again English has got the most replies regarding the frequency of the use of their language skills within the daily work. Nearly a quarter of the respondents indicated that they need to speak English several times a day or week within their daily work, while the majority doesn´t have to use French or Spanish skills for work.

Another block of questions was about the interest of the staff in the participation in international activities, the information about and the actual participation in these activities. The activities language courses, staff exchange, informal discussion with colleagues, who have international experiences, intercultural trainings, training courses and seminars with international topics and conferences with international networking were given. The following diagram illustrates, how strong the employees are interested in such activities, how often they already have participated and if they feel well informed about this offer of activities:



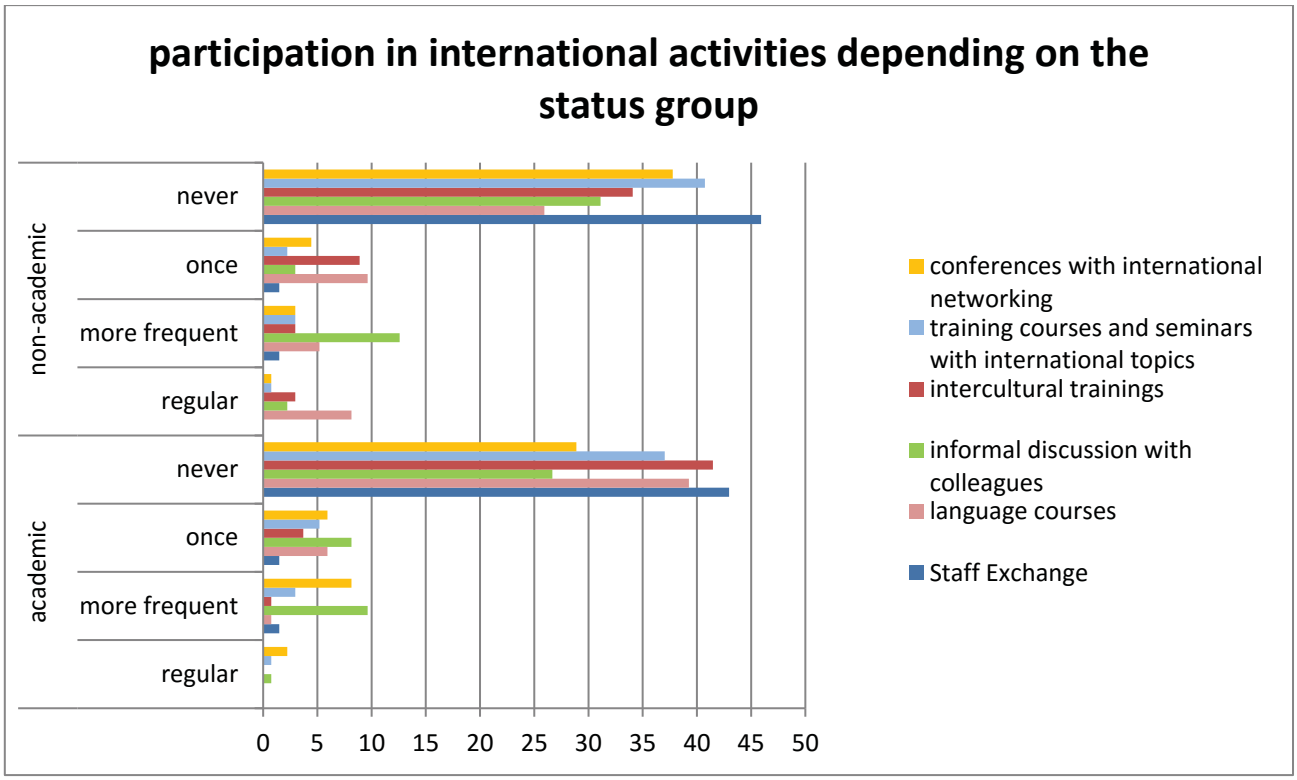
(source: own research)

Figure 8: interest, participation and information about international activities (figures in per cent)

The results show on the one hand, that the personnel generally has a strong interest in the offer and the participation in such international activities, but on the other hand they demonstrate that simply the minority already has participated in those yet and, furthermore, the majority does not feel well informed about these activities and the possibility to participate. For instance, 76% of the respondents are interested to attend a language course, but only 14% have already participated in such a course and only 41% feel well informed about this offer. Even more striking are the results e.g. regarding staff exchange. Here 64% are interesting in doing an exchange, but only 3% have already done an exchange and only 12% feel well informed about this possibility.

The following figures show the results of the analysis with the help of the Chi-Square test of the features participation in international activities and the status group, the type of employment relationship and the volume of employment. At first glance you can see, that the majority of all interviewed persons, no matter whether they belong to the academic or non-academic status group, haven´t participated in international activities yet. Minor differences relating to the status group, the type of employment relationship and the volume of employment are reflected in individual actions.

The first figure represents the results regarding the analysis of a significant relationship between the participation in international activities and the status group:

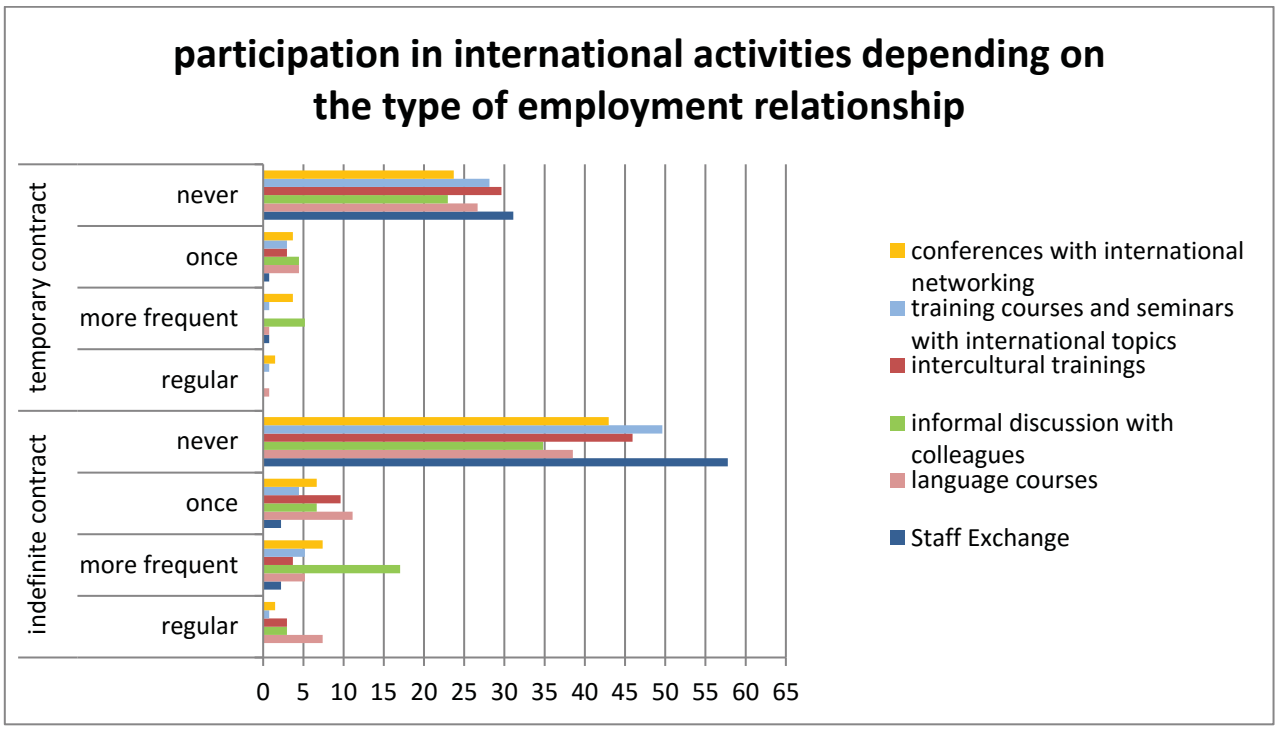


(source: own research)

Figure 9: participation in international activities depending on the status group (figures in per cent)

The figure shows that more non-academic persons already have participated in intercultural trainings and language courses and look for the informal discussion with colleagues who have international experiences and on the other hand more academic persons visit conferences in the field of research and science with international networking.

The next figure represents the results regarding the analysis of a significant relationship between the participation in international activities and the type of employment relationship.

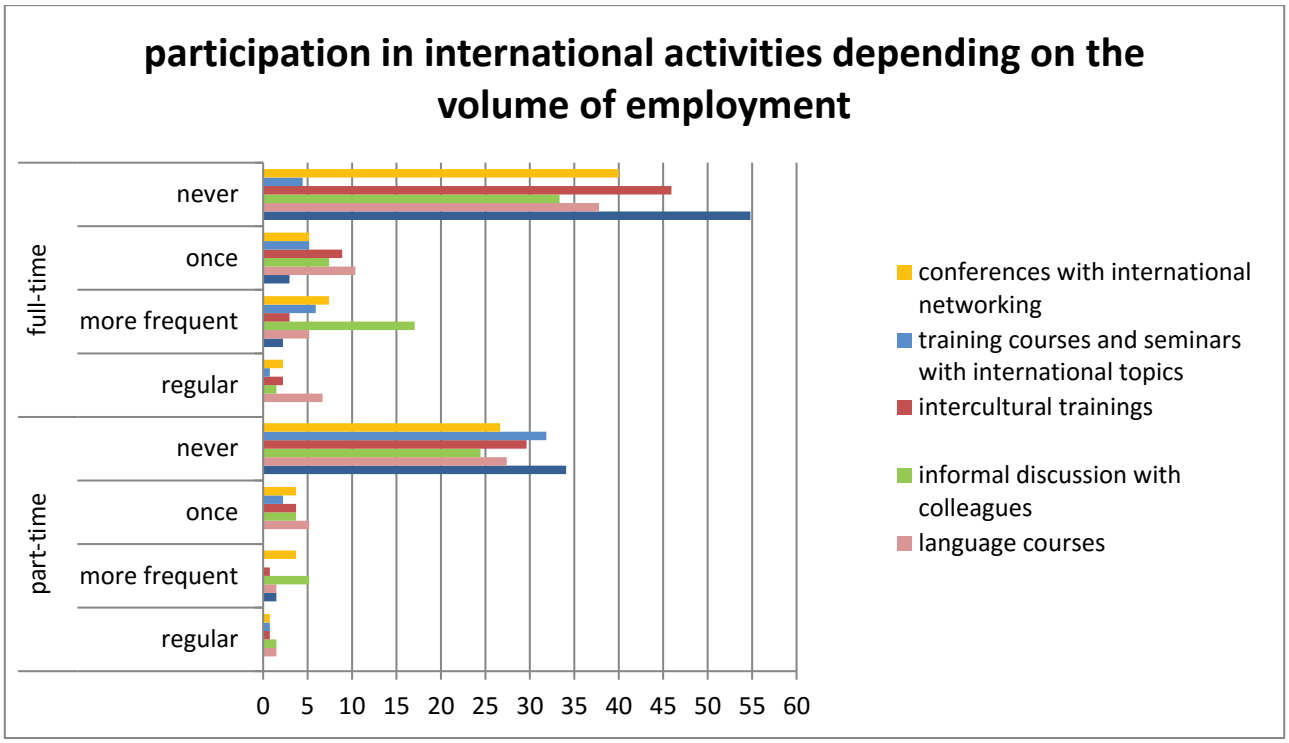


(source: own research)

Figure 10: participation in international activities depending on the type of employment relationship (figures in per cent)

As you can see by means of the figure above staff with an open-ended employment contract look for the informal discussion with colleagues more frequent then staff with a fixed-term contract. Furthermore more unlimited employed employees have already participated in an intercultural training at least once and visited a language course once, more frequent or even regular.

The next figure shows the results regarding the analysis of a significant relationship between the participation in international activities and the volume of employment.

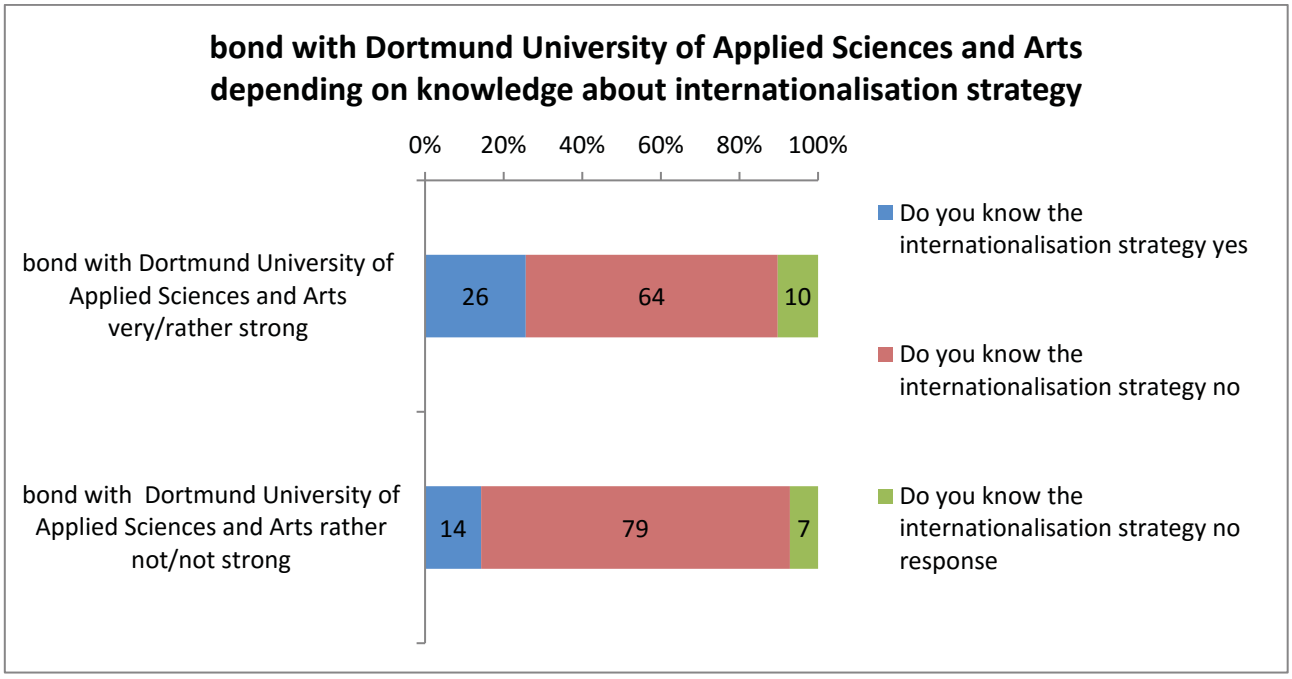


(source: own research)

Figure 11: participation in international activities depending on the volume of employment (figures in per cent)

The figure shows, that staff with a full-time job participate rather more in international activities than staff with a part-time job. They look especially more for the informal discussion with colleagues and participate in language courses and intercultural trainings.

The respondents were also asked for their bond with the Dortmund University of Applied Sciences and Arts and their knowledge about the internationalisation strategy of the university. The results of the survey have revealed that 86% have a close bond with the university and furthermore, that 65% of all interviewed persons don´t know the internationalisation strategy. With the help of the Chi-Square test was analysed, if there is a significant relationship between the bond with the university and the knowledge about the internationalisation strategy, this means if employees, who have a close bond to the university rather know the internationalisation strategy or if these features are independent of each other. The following figure represents the results.



(source: own research)

Figure 12: bond with Dortmund University of Applied Sciences and Arts depending on knowledge about internationalisation strategy (figures in per cent)

As you can see by means of the figure there is no significant relationship between both features. Most of the employees do not know the internationalisation strategy, whether they do have a strong bond with the university or not.

4. Results and Conclusion

The findings obtained from the analysis allow a description of the actual situation of the international skills, competences and experiences of the academic and non-academic staff, so the current status of the internationality can be defined.
The results show, that the majority of the employees of Dortmund University of Applied Sciences and Arts have the German nationality and that just the minority grew up abroad. So the staff of the university is not set up internationally from its origin.
Furthermore they are not really set up internationally relating to their international experiences, skills and competences. Indeed the results show that a lot of the employees have a strong interest in participating in international activities, but most of them haven´t attended in those yet. Only a few persons already have participated in some actions like language courses, international trainings or conferences with international networking. So the majority haven´t got the chance to increase their

international competences, skills and experiences because of a staff exchange for example. This could possibly be due to the fact that they don´t feel informed about these offers or opportunities to participate, as the results have shown.
The question about the language skills show, that the three most common foreign languages are English, French and Spanish and that quite a lot speak these languages quite well, especially the English language, but that they don´t have to use their foreign language skills within their daily work. That means, that there is no need for the staff to speak foreign languages within their daily work because there is not enough contact to foreign people within their daily work.

On the whole it can be stated that the current status of the internationality of the personnel can be defined, but it also shows, that the staff is not set up internationally in a strong way.
The international competences, skills and experiences of the staff have to be increased. This may result in recommendation for action and specific measures to strengthen the internationalisation of the personnel.
An important issue in this context is the information and communication about the opportunity to attend in international activities like language courses, staff exchange, conferences, seminars and intercultural trainings. The personnel have to be informed about these actions and measures have to be advertised. Furthermore they have to be motivated to participate in such activities and that they see the benefit for themselves and for their daily work.

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Effectively Developing Medical Software: Basic Considerations

Alexandru Sereseanu

alex.sereseanu@gmail.com
PQSExpert
Hofsteder Str. 91, 44809, Bochum

Sascha Richter

sascha.tobias.richter@gmail.com
Donau University Krems, Study course: Master of Science "IT in HealthCare"
Herner Str. 191, 44809, Bochum

Keywords: medical software, regulatory requirements, development project, usability engineering.

Abstract: This paper aims at roughly sketching out the regulatory environment relevant to development and deployment of software stand-alone or integrated solutions in the European Union. The matter of how software (SW) development projects are to be planned and executed in highly regulated environments is addressed in the following chapter. The central piece of this work focuses on usability engineering and links to the development process. This is essential for bringing a product into circulation in the European Union.

Introduction

The field of traditional health care is being thoroughly shaken up as we speak by a veritable explosion of new ideas with a strong focus on voluntary health initiatives and ailment prevention. We are witnessing the emergence of a holistic health mega-market which incorporates experimental approaches to biotechnology, alternative medicine, wellness/fitness, dieting, health tourism, self-care, etc. strongly driven by IT&C developments: mobile devices, wearable gadgets, intelligent fabrics, fitness and lifestyle apps.

Speedy advances in SW development have by far outpaced legislation governing medical devices and pharmaceuticals. Current regulatory requirements do not clearly distinguish between lifestyle-/health apps (mHealth & eHealth services) and traditional medical software/in-vitro diagnostics, at least in the European Common Space. As such, device manufacturers and SW developers often tend to under appreciate the importance of properly determining usability, areas of application but also unintended and malicious use of their products. This can have serious consequences in cases where product liability needs to be established. A SW developer is liable for instance should a user (or patient!) come to harm as a consequence of an app transmitting erroneous information. In such cases developers have to prove their due diligence or possibly face huge claims.

Additionally, SW developers would face huge costs and significant restructuring of ongoing operations should they decide post-facto or even be forced by regulatory agencies to reclassify and redesign products for admittance as medical products.

1. Regulatory requirements

1.1 Definitions, classification

For some time now, in the European Common Space, medical software has only been acknowledged as part of a medical device or as a surrogate for such a device. The current definition is provided by the Medical Devices Directive 42/EEC amended by the 2007/47/EC directive. In [1] article 1.2a it is stated that:

*"'medical device' means any instrument, apparatus, appliance, software , material or other article, **whether used alone or in combination**, including the software intended by its manufacturer to be used specifically for diagnostic and/or therapeutic purposes and necessary for its proper application, **intended by the manufacturer to be used for human beings** for the purpose of:'*
—diagnosis, prevention, monitoring, treatment or alleviation of disease,
—diagnosis, monitoring, treatment, alleviation of or compensation for an injury or handicap,
—investigation, replacement or modification of the anatomy or of a physiological process,
—control of conception,
*and which **does not** achieve its principal intended action in or on the human body by **pharmacological, immunological or metabolic means**, but which may be assisted in its function by such means."*

The previous definition recognizes two types of software which can be considered MDs:

Criteria	**Stand-alone SW (including apps)**	**Control (guidance) SW**
Integration	-is not associated with any HW components	-is integrated into a MD
Intended use	-is not associated with any HW components -cannot simply be designated for general health care purposes	-designated for the seamless control of a MD for therapy or diagnostics.
MD Categories	*is classified as an **active medical device** (Annex IX 1.4)*	*assumes the class of its associated device (Annex IX 2.3)*

Additional help in determining if stand-alone SW qualifies as MDs is provided by the guidance document MEDDEV 2.1/6 released by the European Council (EC) in 2012. It provides a decision algorithm with 5 steps, as shown below.

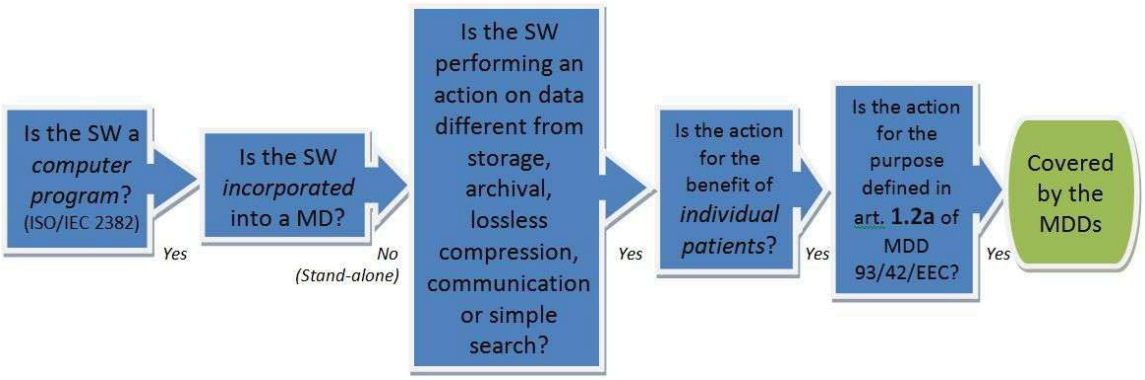

***Figure 1** Decision algorithm for the classification of SW as a MD (based on [2])*

1.2 Organizational process assets required for medical software development

Directive 93/42/EEC requires the establishment of a proper organizational framework (structure and processes) for the development and putting into service of MDs in Europe. This includes:

- a quality management system according to EN ISO 13485
- a risk management system acc. to EN ISO 14971

The framework for planning and executing development activities for MDs is provided by ISO 13485. Chapter 7 of the standard is dedicated to product realization and states requirements for the development process in a heavily regulated environment, addressing the issues of:

- design & development planning
- inputs/outputs
- review/verification/validation
- control of d&d changes

The other key component of the concept phase is setting up a parallel running risk management process aimed at identifying hazardous situations and possible harms associated with the SW product. A traceability analysis enables developers to link system/product requirements to safety requirements. The approach to risk management associated with SW products needs to take into account that SW errors are systematic and hard to predict and should focus on identifying anomalies and function failures that lead to hazardous situations.

The foundation for risk management regarding MDs is based on EN ISO 14971 in association with requirements stated in EN 62304 for an iterative risk management process across the entire SW life-cycle and EN 62366 for the usability of MDs. By achieving compliance with these standards the developer can assume to have the capability to develop a safe and functional product.

2. Development process/MD-SW life-cycle

Requirements on modeling SW life-cycles are stated in EN 62304. The standard describes a generic framework of processes, activities and tasks to be performed in order to be able to develop an application suited for this heavily regulated environment. Compliance is achieved when all these components required for the specific risk class of the product have been implemented. It can be demonstrated by means of the technical documentation including the risk management file and by hosting audits on the specific development processes.

EN 62304 requires life-cycle planning and execution of related activities to span the entire SW deployment from retention to disposal. The particular framework configuration and level of detail are highly dependent on the applications scope and complexity but primarily on risk classification.

The figure below provides a graphical representation of the main/supporting processes and the process interactions involved in planning a MD-SW life-cycle. Of note is the SW validation process group which is set up to run parallel to the actual SW development process and is supposed to oversee the entire life-cycle up to retirement. Another important process group summarizes all the necessary supporting processes such as risk or document management which also run parallel and feed into to the main processes.

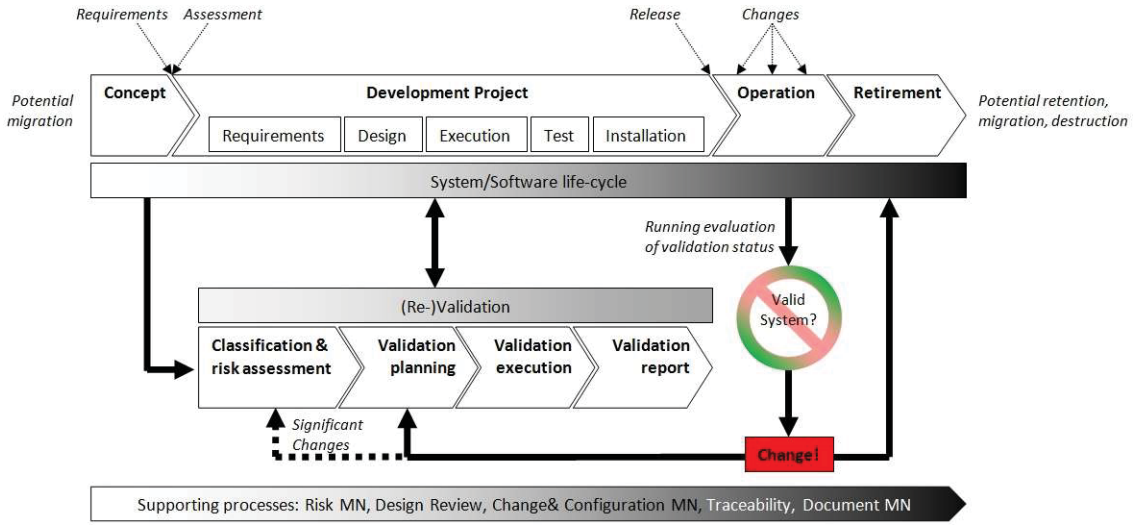

Figure 2 *MD-SW development projects as part of the entire life-cycle (based on [4] p. 170 and [8] p. 26)*

3. Usability Engineering/ Concept: collecting requirements

If a MD includes SW or a stand-alone application qualifies as an active medical device then it must have a defined life-cycle and be validated depending on its risk class. Requirements for the validation procedure provided by EN 62304 are closely connected to the general requirements to Programmable Electrical Medical Systems (PEMS) in EN 60601-1. This standard addresses

basic safety & essential performance issues and has close ties to ISO 14971. The essential requirements also call for defining the intended use and use errors for any MD seeking market approval. Usability engineering (acc. to EN 62366) constitutes the foundation for the RM process and is linked to ISO 14971 as well. The following figure shows the V-Model as the standard development framework for medical systems and the overlapping coverage areas of different relevant standards.

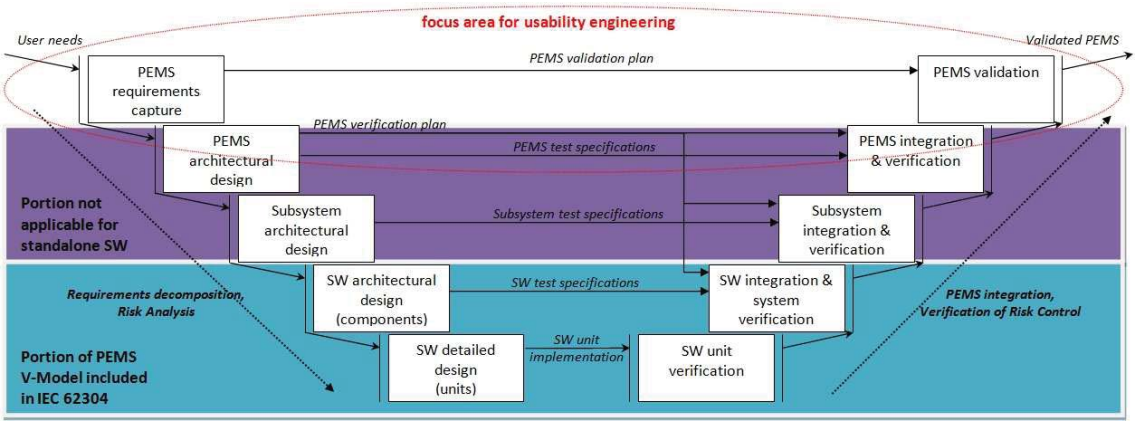

Figure 3 *MD-SW as part of PEMS development (based on [5] p. 58)*

It is mandatory for SW developers to collect requirements for the usability of their product even prior to project initiation. Developing these requirements entails identification, analysis and documentation of information regarding the product and its intended use in the form of a SW requirements file which contains information such as:

- SW system inputs/outputs
- SW functions
- performance specifications
- hardware specifications and operating system
- scope, area of application and limitations
- security related specifications related to features and functions to be implemented

As shown in the previous figure, the main efforts of usability engineers are grouped towards the beginning and the end of development activities. This is partly due to the fact that the user experience also spans from idea retention to post product disposal and requires proper management in a timely fashion. The following figure shows some of the activities typically involved in usability engineering.

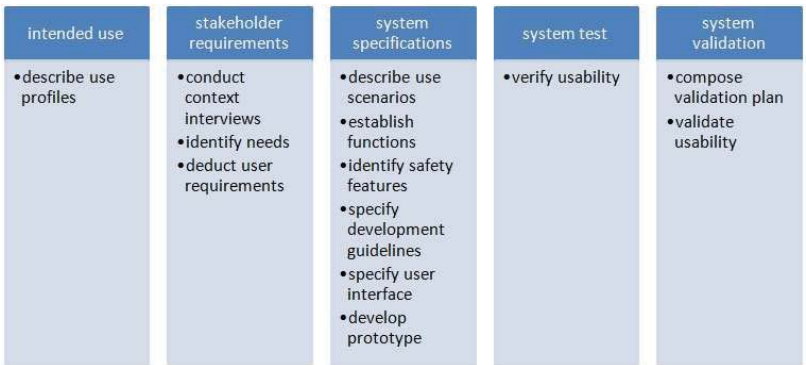

Figure 4 *typical usability engineering activities*

4. Results and Conclusion

The previous chapters have highlighted the state of European regulation concerning SW products which can be categorized as MDs. As shown before, the current regulatory status quo allows for few variations in MD-SW category. However, recent developments in the fields of practice have brought forward some innovative applications which go beyond the boundaries set in aging EC directives. It becomes clear that at least in Europe there's a need to rethink and adapt the regulatory framework to fit the new realities in the markets.

In a recent stream of studies on the healthcare sector, the WHO recognizes that "mHealth" (covering "medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices") is a market with exceptionally high growth and innovative potential. The European Commission (EC) green paper on mHealth also acknowledges prospective applications for increased prevention/quality of life approaches, more efficient and sustainable health care as well as a potential for more empowered patients. This stakeholder consultation highlights some of the issue that would need to be addressed sooner rather than later in light of the sectors rapid development [3]: data protection including security of health data but also aggregation of big data pools, patient safety and transparency of information, product safety, market regulation and compliance as well as entrepreneurial access to the market.

Regarding prospective market applications, one of the WHO surveys shows that in developing countries mHealth applications are driven by the basic need of access to primary health-care services while in hi-income countries it is driven by the requirement to increase efficiency. In the EU one of the most prominent trends is that of increasing patient autonomy by designing wearable, portable or implantable systems. It is also estimated that these application could potentially save billions in the EU trough wellness/prevention, treatment/monitoring and workforce reduction.

In conclusion, recent developments coupled with optimistic predictions for the alternative health-care sector paint a picture of an extremely attractive and lucrative market for a host of actors such as software developers and service providers. However, the environment for developing SW which qualifies as medical devices is highly regulated. This means that developers will need to fulfill essential requirements to their management systems and processes even before designing any products or services. This is due to the extended safety considerations for patients and users that need to be taken into account. As such, managing the life-cycle of a MD is going to be more costly in terms of time and money. Even so, the potential gains but also overall saving should prove to be effective incentives for both suppliers and customers of medical software, especially those who already have extensive experience in the clinical field.

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How agile procedures could support the mechatronical development process

Nadine Sticherling

nadine.sticherling@hs-bochum.de
Alumna
University of Applied Sciences Bochum Campus Velbert/ Heiligenhaus
Höseler Platz 2, 42579 Heiligenhaus, Germany

Keywords: agile methods, mechatronical products, V-model, simultaneous working, T-CoachIng

Abstract: The challenge for the development of mechatronical products is to bring the procedures of the tree disciplines mechanics, electronics and software together into a simultaneous working process. Originately coming from the software development agile methods are transferred more and more in mechatronical development processes. How agile procedures could be integrated in a practical mechatronical development process is been analyzed and approaches are found in the following on an example of an automotive supplier.

1. Introduction

The challenge for automotive suppliers is to develop long live reliable products with high efficiency in shortened times. Most of these today's suppliers have grown up from a traditional mechanic developer to a company for mechatronical products. The author herself works at a German automotive supplier and is responsible for the development of a mechatronical sensor system. For her master thesis she analyzed the development process and gained an insight, how innovative products could be developed by using agile methods.
The development process of this automotive supplier based on the V-model, which is preferred for mechatronical development processes by the VDI-Standard 2206 [1]. One big challenge for this development process is to build up the different models with their levels of functionalities. With the help of an interview, the author asked other developers about their experiences with the V-model and which aspects of this model are helpful for their daily work and which aspects could be improved.
Beside this consideration on the V-model the different parts of mechatronic – mechanics, electronics and software – were analyzed with a focus on its different procedures during a development process. How these parts could effectively work simultaneously and where useful synchronization points for an effective and close collaboration are was the aim of the analysis.
The developer himself is the second influence on the development process. His knowledge, motivation and working procedure increase the influence of the produce quality.

2. The two pillars for effective mechatronical product development process

There are two important elements for product development: on the one hand is the developer. His motivation, working procedures and identification with the product build up one pillar for the practical process. On the other hand is the theoretical development process. It describes the different individual phases of development process, the different built up models and iterations, the collaboration between the team members, the process description, the requirement engineering and time management. These several parts represent the second pillar. Both pillars are the basis for the practical development process.

Long time projects with a high amount of work require motivated developers with specialized knowledge. How they can be motivated is given by the theory Y by McGregor. [2] By this theory Y the staff member is intrinsically motivated. He wants to reach the project aims by himself without getting instructions step by step. He is responsible for his procedures by himself.
The claim on the theoretical development process is that it includes the different models and iterations. Furthermore the process affords a close cooperation between the different departments. Beside this the process has to be flexible for reacting changed costumer requirements and timetables.
These two pillars of a development process are reflected in the interview with the developers of the automotive supplier. The main topics which are identified are the collaboration between the different departments and within the department. One aspect on this topic is that it is not possible to work in real parallel streams. One next topic is the acclaim to create working situations in which the developers are able to work independently. Beside this the developers find lacking an organized transfer of knowledge. The development process itself should be able to allow running through the V-model in iterations. In this case it is possible to include the different functional models and increase the requirements and functions of the product.

3. Agile procedures as proposals for solution

The basic principles of agile procedures come from the two Japanese professors Takeuchi and Nonaka, who wrote many articles about agile methods. One article engages in the holistic product development in which describes characteristics in agile product development process [3]. Four characteristics are the basic for the generated results:

- set in iterations and models into the development process
- true simultaneous working
- cooperation interdepartmental
- transfer of learning from old projects

A characteristic of innovative products is that usually requirements are not known until the beginning of the development process. To transfer the setting iterations and models means to run through the implemented V-model from the automotive supplier several times. Based on the macro cycle of the V-model all conclusions from the design and test process can be transferred into the next generation of functional model of the product.
For true simultaneous working the procedures and working steps of the different departments are founded out. The result of this analysis is a sequence diagram of a detailed work description with feasible synchronization points.
One aspect, also discovered in the interview, is the cooperation only department wide. With concretion of the development process the intensity of collaboration has to become more intense, because the developer need the increased contact between each other to solve upcoming problems or technical disagreements fast and in time. The solution for this aspect is to realize the spatial adjacency during the project time.
Another identified aspect in the interview is the fourth shown characteristic: the transfer of knowlegde from old project. Together with two further aspects – the feeling of being directly controlled by the costumer and the less freedom of self-organization generate the basic for a new approach of leadership role – the T-CoachIng. This role includes two new roles of the development team: The first role is the project manager, who leads and motivates his team as a team coach with the methods of the short described theory Y from McGregor. He is the barrier between customer and developer. His leadership based on the leadership of self-organizing teams and puts the developer’s responsibility for his procedures on the developer himself. For mechatronical projects it’s important that the project manager has a so called T-shape personality, which means he has an interdisciplinary skill of mechanics, electronics and

software development and has specialized knowledge of some parts of this disciplines. The second role of the T-CoachIng is an external, non-team member, who is a senior employee with experienced technical knowledge. He reflects his knowledge from former projects and teaches the respective developer, available from the beginning of the project. Due to his special and profound knowledge he has an I-shape personality.

4. Results and Conclusion

The analysis of the development process of an automotive supplier for mechatronical products clarified the relationship between the procedures of the developer and the development process. An interview showed the practical V-model with its perceived conflicts. For approaching the conflicts four agile procedures are used. These procedures are: set in iterations and models into the development process, true simultaneous working, cooperation interdepartmental and transfer of learning from old projects. With the help of them the two shown pillars for an effective practical development process could be encouraged, which is the basic for a sophisticated product. The main new aspect of this analysis is the new approached role – the T-CoachIng, in which the project manager and an external senior employee provide the development team to a self-organized and self-responsible team with an expert and technical knowledge.

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The need for "Situational Leadership" in managing complex projects

Shah, Syed Muhammad Omer

smomers@gmail.com

Dortmund University of Applied Sciences and Arts, Dortmund Germany

Keywords: Project Management, Complex Projects, Leadership, Change

Abstract: 21st century project management demands appropriate leadership from the project manager who deals, on daily basis, with innumerable uncertainties and complexities of evolving nature. We have witnessed, over the years, a paradigm shift in the leadership models from top-down, purely bureaucratic style to participative and situation-based leadership. In today's project environment, project leadership has been identified as one of the critical success factors [1] that considerably enhance the chances to deliver projects within budgetary and schedule constraints and also meeting the desired outcomes. This paper emphasizes the need for a leadership model that focuses on managing both the complex task associated with today's project world and also understanding the need to foster personal behavior of the project team member(s).

1. Introduction

Over the past three decades, there is a significant increase of interest in the field of project management and that is why the role of an effective project manager has also come under light. The 21st century economic realities demand the project organizations in general and the project managers in particular to prepare themselves to survive and grow under a "complex competitive landscape" [2], one which is based on technological innovation, global underpinning [3] and which involves several stakeholders who directly impact the project performance. Organizations survive and thrive on the basis of a single commodity i.e. "knowledge" which differentiates between rapidly growing and underperforming organizations. Given the alarming failure rate of projects, particularly those involving complex technological implementation with a staggering 52.7% of projects costing 189% of their original estimates [4] points out that there is a need to shift from the traditional strategies of managing projects and more importantly the role of the project manager must be aligned to meet today's challenges.

To meet the challenge of creating new knowledge in a project organization and staying abreast of the technological innovation, a great deal of literature has been written which emphasize on the dynamism of environmental factors and the need for the project managers to hold leadership role. Kotter and Mintzberg are of the view that business environment continually face “change, uncertainty, volatility and complexity” which requires a project manager to adopt a well-rounded leadership style [5], [6]. Berg and Karlsen found out that the project success is dependent more on human factors such as leadership, executive level support, project team integration etc [7]. This paper aims to identify the most appropriate leadership style of the project manager who increasingly manages projects with higher complexity levels.

2. Leadership in a Complex Adaptive System

A “complex adaptive system” is an unstable structure with multiple interlinked and overlapping hierarchies which are interactive and dynamic in nature. For the past several decades we have mastered to manage traditional and linearly oriented projects. Such projects have a well-defined, and in some cases, fixed scope of work [8]. We have also found that, for such projects the budgetary and schedule considerations are realistic and clear from the outset of the project. The goal of a traditional project is also stationary.

On the other hand, the projects operating in a complex adaptive system are attributed to have “emerging” properties. Such emergence is caused by the interaction of “apparently” independent components. Kerzner and Belack have identified such components that give rise to, and also enhance the complexity in a project [8], for example project size, dollar value, uncertainty in requirements and deliverables, large number of stakeholders, complex interactions, culturally and geographically spread out teams and other factors that increase uncertainty.

The leadership theory governing the dynamism of complex adaptive system rests on the strategies and behaviors that help inducing organizational creativity, learning and adaptability [9] that is triggered in response to the interaction of competing components of the adaptive system. In a complex project management environment, the effective leadership requires a rational understanding of the situation at hand and responding appropriately in order to achieve the desired outcomes.

3. Situational Leadership Model

According to Harold Kerzner, Dr. Paul Hersey and Ken Blanchard's Life-Cycle Leadership model [10] is the most appropriate model in a project management environment [11] which was developed in early 1970s. This model was further developed and reshaped to be called as "situational leadership model". The core concept of this model is that, there exists no single "best" style of leadership. They argue that there are four fundamental leadership styles and the leadership effectiveness demand that these styles must be adopted according to the maturity level of the individual or group being led. The maturity level is explained by the job-related experience, ability to own the responsibility and willingness to achieve the organizational goals.

In a complex project environment, where the project scope is relatively large, involving equally large number of stakeholders with conflicting interests, project outcomes are uncertain and an unstable external situation; there is a higher need to foster an enabling environment for the project team [12] to perform at the optimum level.

Situational leadership model sees leadership effectiveness in a task-relevant perspective. Secondly, the situational leader must reflect on the readiness of the follower(s) by analyzing the individual and/or group's ability and willingness to take up the responsibility at hand. Keeping in view of these considerations, a situational leader must apply the leadership style that is most relevant in the given situation.

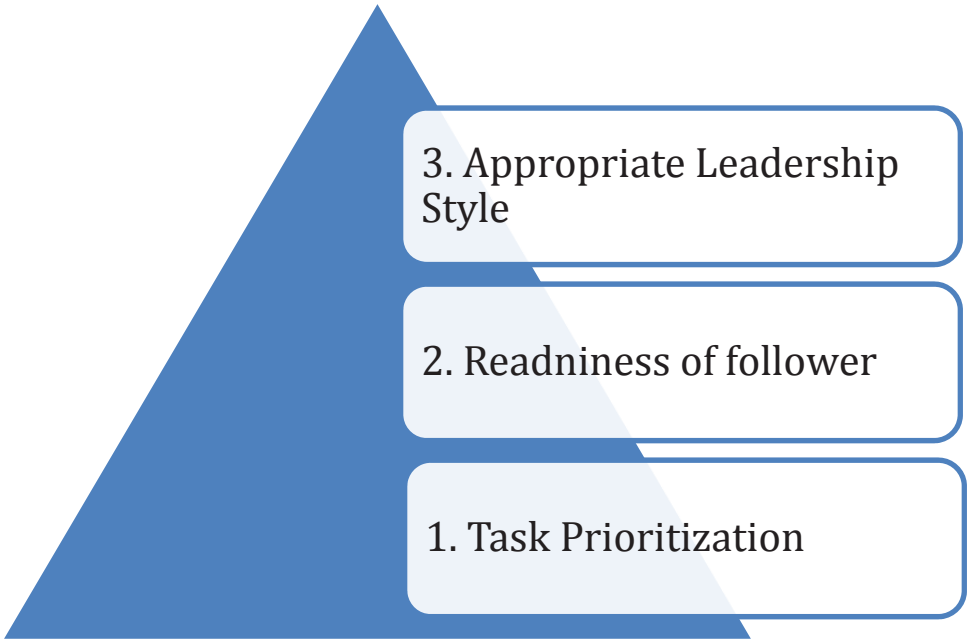

Figure 1: Steps in Situational Leadership

4. Leadership Styles in Situational Leadership Model

The developers of situational leadership model identified four basic task-relevant leadership behaviors which are as follows:

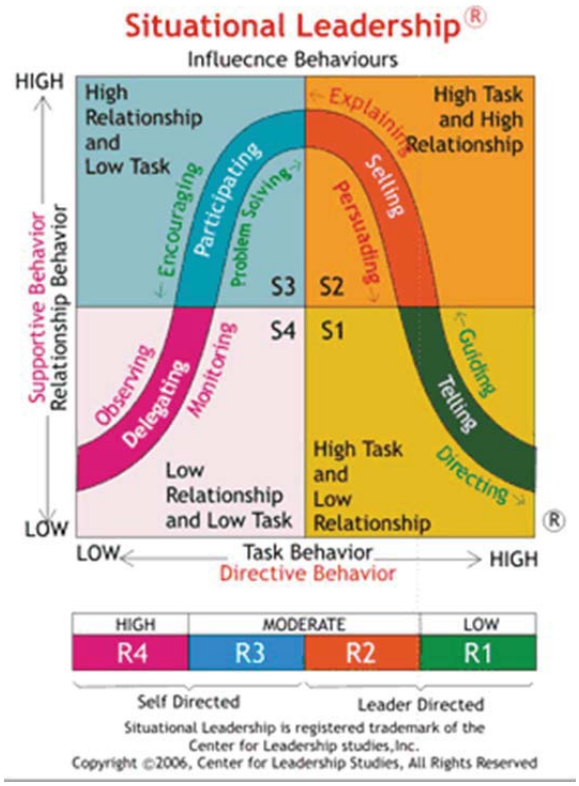

Figure 2: Situational Leadership Model [13]

1. *S1: Telling (Delegating)*

This leadership style is attributed with the one-way communication in which the leader "tells" the follower(s) about the roles and responsibilities and he/she describes "what needs to be done". More precisely; what, how, when, where and why questions are answered. The creativity of the follower under this leadership style is at a lower level and a greater degree of "compliance" is expected. This leadership style is most appropriate when there is a low "willingness" and "ability" level on the part of the follower: It also requires a considerable amount of supervision from the leader.

2. *S2: Selling (Coaching)*

This leadership style is appropriate when the follower(s) have relatively higher willingness but not fully "able" to undertake the tasks. Supporting, like delegating, also require the roles and task directives from the leader. On the other hand, the

follower is expected to share ideas and suggestions to make effective task delivery. It is also notable that the decision making power still largely rests with the leader who is expected to provide coaching and instructions to the follower. It can be said that this leadership style ensures a two-way communication to some extent which helps providing a certain degree of autonomy to the follower to master the skills by discussing the issues with the leader and seeking his/her guidance on critical matters.

3. S3: Participating (Supporting)

This leadership style is based on the principle of shared decision making where both the leader and the follower together reflect on the task at hand. The leader's role is higher on the relationship side and relatively lower on the task side. The leader helps motivating and building confidence among the followers so that the tasks that the follower(s) is already capable of performing also have a greater support from the leadership. This style involves appreciating the follower on showing a commitment to perform the tasks in the appropriate fashion.

4. S4: Delegating

In this leadership style the leader still holds the decision making power but acts only as symbolic head of the group he/she is leading. The main processes and core responsibilities are shifted to the individual or group taking up the task as they are both willing and able to perform the task at hand. The leadership style helps building trust within the project team and all members have the self-awareness that they possess right skills and the right amount of willingness to perform the project tasks.

5. Conclusion

Complex interactive dynamics of today's projects require a certain leadership model that not only reduces the complexity but also help in building a project team based on "readiness" that possesses knowledge, relative independence and the ability to take responsibility when managing such endeavors. Situational model helps achieving all the mentioned objectives when managing complex projects with large size, higher uncertainty and requiring a large number of stakeholders.

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Beyond Agile – Highly Adaptive Project Organizations (H.A.P.)

Stephanie Borgert

info@stephanieborgert.de
denkSystem
Lange Kuhle 43, D-48163 Münster

Keywords: complexity, agility, sustainability, project organization, highly adaptive projects

Abstract:
Some people say that “agility” is the answer to the question on how to manage projects in a complex environment. The high degree of uncertainty, the lack of transparency and the dynamic are just some aspects of our projects these days. This brings up the search for the “right” methodology and an approach to stay successful. But agility is not a methodology at all and it does not provide all the needed details that project managers need to complete their work. This paper introduces a model that helps project managers set the necessary screws, so the project itself can master complexity, stay flexible and agile and even survive relevant crises: the model of Highly Adaptive Projects (H.A.P.).

1. Introduction

Which is the best methodology when it comes to managing complex projects? Which one is modern? Which one fits best for what kind of goal / theme? When discussing these questions, people quickly come up with one answer: „Agile Project Management“. Agility is modern, but not new.

The greatest attention was generated by one model, which comes from the area of software development: SCRUM. Known and tested for a long time in IT only, the method has expanded into other industries. Today there are many discussions happening in all kinds of organizations about the agile approach, agile methods or agile management. An example: "Oh, you are working agile? So you are performing SCRUM." The model is put on the same level with the approach. As a matter of fact, SCRUM is only one model and by no means is it the only one. This error is only the beginning of a chain of misunderstandings on the subject of "agility".

2. Agility is not a method at all, but a mindset

Many projects that are managed with traditional process models are not customer-oriented and not sufficiently effective. This finding developed SCRUM, this new approach that would revolutionize the software development industry. By now has been established even outside of IT projects, in order to make organizations more agile and leaner. Whether it is SCRUM or a form that is mixed with the traditional approach, the mistake is to mix up the mindset and the method.

It starts with the promises of agile coaches and consultants. They sometimes promise that implementing agile methods increases productivity, elevates motivation in the team and raises employee satisfaction. It sounds as if there is a linear relationship: Method in, productivity out. This clearly is not the case, because we operate in complex systems that aren’t predictable. Furthermore, agility itself is not a method, even if the most prominent representative SCRUM comes with clear roles, activities and artifacts. However, in order to deploy those in a target-oriented way, you will need a mindset that allows self-organization, transparency and discourse. With only daily stand-up meetings or naming a product owner, the promise of higher

productivity or motivation is empty. The reverse becomes true. Only introducing a new method makes agile projects more likely to fail. People then turn back to “We have always done it this way”.

3. Agile principles are too vague

Four principles form the Manifesto for Agility and building the basic values for working the agile way:

- Individuals and interactions over processes and tools
- Working software over comprehensive documentation
- Customer collaboration over contract negotiation
- Responding to change over following a plan

SCRUM brings in additional role definitions, artifacts and lots of terms, such as self-organization, freedom in planning or democracy. All these principles, values and rules are important and fine, but need to be seen in the correct context of the organization or the specific project. If this does not happen (and this can be observed quite often), the terms remain too general and the number of misunderstandings and misinterpretation increases. Agile teams, for example, are referred to as self-organized, and at the same time self-organization is praised as one of the success factors of agile methods. Yes, agile teams are self-organized; this is true for every complex social system. What is truly meant when talking about agile methods, is self-monitoring or self-management. Teams themselves decide on tasks and responsibilities, there is no project manager who assigns the work packages. This is self-monitoring, not self-organization. When the common language is unclear and phrases and concepts make “no sense”, it will lead to many misunderstandings. Additionally, concrete ideas about how to implement "responding to change" in an organization are also needed. What characteristics and skills does a (project)-organization need to have in order to successfully work agile?

4. Resilience and Highly Adaptive Projects

We´ve all heard about the so-called “stand-up-men”, people who have overcome severe tragedies and crises and stood up stronger in the best-case scenario. Athletes who had an accident, which forced them to start anew.....and then start at the Paralympics, years later. Celebrities, after fighting a serious cancer, who find their way back into the limelight. People who went through many personal crises in their lifetime, but were not broken by them. They managed the crises. We consider those people to be robust, crises-proofed, “tough”, and resilient. In the context of project management resilience means recognizing errors and turbulences early on and identifying solutions quickly.

How many reports about complex projects, which are characterized by resilience and stand-up mentality are you familiar with? None? Exactly, we read and hear about major projects in public only when they are in real trouble. When Stuttgart 21 increases by several ten million euros, the health card has severe security problems or the opening of the new Berlin-Brandenburg Airport is postponed once again. What happens then often follows a certain pattern: We are looking for the causal relationship, find the culprit, name the source of the mistakes and fix it anew. We analyze cause and effect and find out how to make those projects more robust. It is the way we try to avoid mistakes, crises and turbulences.

Cause-effect versus Interrelation
So we install a more widespread risk management, get to the bottom of the mistakes (as much as possible) and again, confuse causation and correlation. We have learned to think in a cause-effect relationship and to approach problems by analyzing them, so the issue for us is switching over to look at the interrelations. Approaches that only focus on robustness and error prevention do not fit in complex contexts, because a degree of uncertainty and unpredictability always exists. So we need to take a look at what makes project organizations more resilient.

Resilience means the ability to detect errors and turbulence early on, to identify possible solutions quickly and to get out of a critical situation promptly. A resilient project organization adapts itself easily to changing circumstances and conditions.
Because we don't read publications about success stories of resilient projects, does not automatically mean they don´t exist. They do, and we should learn about the factors that make a project more adaptive from them. These factors can be named and located in every project, more or less distinct.

5. The model of Highly-Adaptive-Projects (H.A.P.)
If the following model of Highly-Adaptive-Projects (H.A.P.) is presented, it is to be understood quite clearly on the basis of complex systems and not as a cause-effect-structure. The behavior of every individual in a complex project system affects the system, and vice versa.

The H.A.P.-Model
The model describes the characteristics and skills of an adaptive project, which then can be used as set screws for its resilience.

The main dimensions, which can influence the adaption of a project, are:

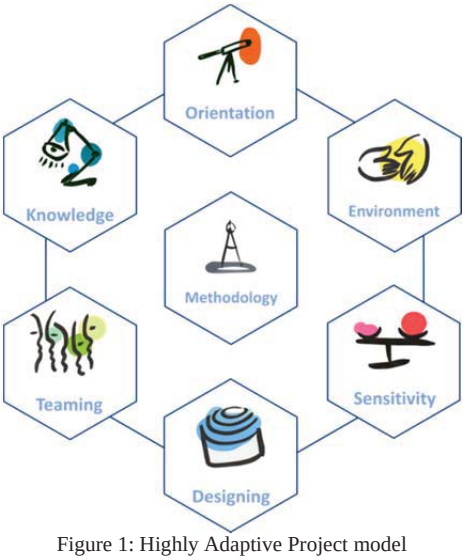

Figure 1: Highly Adaptive Project model

Each dimension consists of various facets, some of which are exemplarily presented here. Each project provides a quality in each dimension and facet; the question is only to what extent. Non-resilient or non-adaptive projects do not exist, there are only more or less resilient. Resilience is a process.

- **Orientation**

Each project, as well as each individual, has his or her own representation of time. Some are living more in the past, some very much in the present; others are already in the future. Is your project rather transfixed on problems of the past or does it actively create the future? Aspects of personal responsibility and target-orientation play a part here as well. In nearly every project the answer to the question of target-orientation is: ”Of course we are target-oriented.” Ok, but how and in which way are you discussing this in project meetings? Are people discussing the current situation and it’s problems or are they discussing how to achieve the target. This is only a supposedly subtle difference, which has a significant influence on the orientation of people’s thinking in everyday discussions.

What is the tenor in the team’s discussion? Is the glass half full or half empty? Of course, every High Performance Team needs its pessimists. At last they provide a certain degree of awareness regarding problems and imminent crises. The prevailing mood, however, should be optimistic. A project team that is able to recognize its own failures and successes and realizes what this has to do with their own competences and actions will be able to get out of a crisis much faster.

- **Environment**

One for all - All for one. In a complex system every individual is responsible for the quality of cooperation. Therefore, confidence is the necessary basis for this system and can be established through communication and transparency. In highly adaptive projects cooperation, not competition comes first.

In a dynamic complex environment, cooperation is the mechanism that supports the interconnection of people. It makes sure that information flows, people interact and cooperate with each other. Thus, the “social capital” within the project will be built. If it's getting turbulent, people as well as projects need stable relationships to overcome the crisis quickly and without harm.

- **Sensitivity**

How intensely are you paying attention to the weak signals of your project? How long are they overheard or ignored? Until the crisis becomes immense?

Unfortunately, that's exactly what happens very often. In fact, there is no project turbulence that happens unannounced. It starts with rumors, through the grapevine, a gut feeling- these are often the first indicators of “something is about to happen”. But is it noticed?

The team should pay attention for a moment and make the determination, whether or not this signal should be followed. And if we are already stuck in a crisis, acceptance is the key for a fast escape. In adaptive projects the stages of denial, anger and possible negotiations are short once the crisis is accepted. At this point, the project manager has significant influence; he should be the first one to accept “what happened”. This defines the capacity to act for the entire project team.

- **Designing**

Question: “How do you handle failure and errors in your project organization?”

Answer: “Well, mistakes are actually permitted....”

In most project organizations, you will see that mistakes are sanctioned. It's obvious that no error management culture in terms of resilience exists. It is essential however.

Good examples are given by so called high-reliability-organizations (HRO), such as fire departments, aircraft carriers or emergency rooms. In these organizations, errors and mistakes can easily have fatal consequences, which is why the staff pays very special attention to them. “Almost-errors” are not seen as an affirmation of success, but as a hint that something in the system may not be running smoothly. Errors are used to learn about the systems behavior.

Talking about the error management culture brings us right back to the point of confidence. Only in a trustful atmosphere it is possible to report errors and almost-errors without being punished. Otherwise the staff quickly learns that mistakes are not allowed and they will sweep them under the rug. A good strategy of error prevention is paying attention to weak signals and a mindset that is accepting of “Something always happens”.

- **Teaming up**

“Same attracts same” is the motto that is reflected in many project teams. We feel most comfortable in a circle of like-minded people. They're a good match, there is little to discuss. We don't have to argue about our opinions and points of view. That's convenient, but not promoting resilience.
The magic word here is diversity. An adaptive project consists of people with different opinions, ideas, experiences, backgrounds and skills. Variety increases adaptiveness. Generalists normally complement a project team with transfers of overlapping subjects and good conceptual thinking. The diversity first appears in discussions and here it will depend on the language used in discussions.
The scientist Marcial Losada discovered that “High-Performance-Teams” communicate in a proportion of 6:1 of positive to negative language. The proper proportion provides the balance between ‘taking off’ and ‘remaining on the ground’ and therefore also resilience. The successful implementation of diversity in project management is only achieved if the basis of cooperation is confidence and mindfulness. Diversity is then mirrored in the language used by the team members.

- **Knowledge**

One attribute of complex systems is the lack of transparency. In an interconnected project environment with many interactions even an experienced project manager is no longer able to understand the whole system by cognition alone. He needs a skill that everyone possesses, but which is rarely taught. It is called intuition. This does not mean he should use his own intuition, but rather the collective one. To rely on the intuition of one individual alone can lead to wrong decisions quickly. The collective intuition, however, is a powerful instrument, which helps to make decisions in complex contexts and thus, manage the project.
When talking about complexity, we have to discuss “time to play” and innovation. If decisions cannot be made by analysis through experts only, a new approach is necessary - innovation. What does that have to do with “time to play”? If you are in need of new ideas, concepts and solutions, the staff should have free time to think things through. On one hand, this means that the team can insert even unusual items and thoughts outside the box. On the other hand, the members need a temporal (if necessary regional) frame, in which “thinking out of the ordinary” is welcome. The more often this is allowed and taught, the faster scenarios for solutions can be generated in case of possible project crises.

6. There is no benchmark for resilience

It would probably be very nice and practical, if there were standard values for each dimension, “resilient” or “not resilient”. They do not exist. Each project is moving on an axis inside every individual dimension. A statement about the quality of the positioning and the possibilities to increase the resilience can only be made in the particular context of the individual project. But one can start by discussing the facets of the H.A.P. model with the project team. So they may find a common language, make sense of what they are talking about and get on a discourse. That is the first step on the ladder of resilience.

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Getting Contract Using Psychological Approaches

Snahovskyi Maksym, maks__4@mail.ru
Snahovska Mariia, sms71@mail.ru

Master students
Kiev National University of Construction and Architecture
31 Povitroflots'kyi Ave, Kiev, Ukraine, 03680

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Abstract:

Successful project is the main aim of project managers. But while the implementing of it there will be a large number of obstacles to overcome. In this article we would like to pay your attention on the relations between the project manager and the client at the initial stages of the project. If project manager wants to lead the project, he has to convince the client that his company is the best option. This is where psychological approaches are the main tools for the project managers to achieve their goals.

1. Introduction

For every modern organization client is the main person of the manufacturing process. Neither technologies, nor equipment, nor unique knowledge can provide the prosperity of the company, unless the client claims them.

In IPMA Competence Baseline (ICB) version 3.0 project success is the achieving project's objectives within the agreed constraints [1]. In the current environment of rapid changes and high competition the level of client satisfaction should be named as one of the most important criteria of the project success.

However, experience shows that the client must be satisfied not only with final product, but also with the process of its creation. When a client applies to the project manager (PM company or a project team), more than 85% of his requirements are superficial and have abstract descriptions of the final product. Project manager and his team see the same product as a set of specific activities and tasks, which can or can`t be performed. Here is the dilemma in which the project manager has to find a balance: the customer's requirements and the capabilities of implementing the project.

The process of interaction between the project manager and the client sets up a large number of complexities that often leads to misunderstandings between the parties and the emergence of conflicts due to the different opinions on the project itself. This situation can occur on the stage of project initiation and planning, which are the first major stages in the project. Mainly on these steps client usually build the foundation of entrust to the project team.

However, as we know, to start any project we need to sign the contract after some negotiations with the client. That is where the key points are clarified, such as project time, the amount of payments, risks and opportunities are determined, etc. Today, there are many classic recommendations about ethical standards and professional behavior during the negotiations, but this is not enough [1], [3]. Now we notice that for successful negotiations we should take into account the characteristics of the client both as a symbol of the represented company and a person with individual character. Project manager should understand not only the technical specifications, but also take into account the peculiarities of his character, to avoid all kinds of conflicts.

Every project manager should be capable to answer the question: how can the client be satisfied with the process of the product (service) creation, if he does not take part in it? Here is the place where the project manager has to find an approach to the client using psychological methods to prevent and resolve conflicts.

2. Basic temperament approach by Hippocrates

As it is known, there is a classical theory of division people into 4 types of temperaments. It was proposed by Hippocrates, and despite the fact that now there are dozens of other classifications, they are derived out of it.

A person with any type of temperament may be capable or incapable to solve any kinds of situations - temperament type does not affect the person's ability, just one vital problem easier to solve one type of human temperament, the other problem is easier for another temperament. Here is a brief description of these types of temperament which every project manager can put in practice, while analyzing the client. There are four basic types of temperaments: sanguine, choleric, melancholic, and phlegmatic. [5]

Sanguine people are very live, compromise, optimistic. They can easily switch from one activity to another, they are flexible, sociable, have a balanced nervous system, quick, but thought out to respond into different challenges and situations. They are hardworking; it is easy for them to renew forces after a hard day's work, people-oriented, make up their mind to failures and use all gained experience. [4]

Sanguine are excellent managers, but only in those areas where they can use their resourcefulness and creativity. The routine work make them lose their interest and reduce the effectiveness. They are easy to communicate with, but only in those cases when they are interested in that subject. [6]

Choleric is also active and purposeful, but uncompromising and fussy. They are dominated by emotions. This type is inherited with unbalanced nervous system, inability to restrain themselves and rash decisions making. They are enduring, but restless, have instabilities in both mood and work. Often, these people are hostile to things they do not like. Emotions are very strong and bright. This type is not that negative: it has the same qualities as the other temperaments, but they are so pronounced that it is often perceived as negative. This type of people is not suitable for work requiring attention and patience, are difficult to communicate, however, they are the most active and initiative to work with. [4], [5]

Phlegmatic type is much closed. These people are peaceful, balanced, permanent in their preferences, patient and have good self-control. Even their moves are very monotonous; the mood is always stable. They are self-controlled, but at the same time strong and confident, imperturbable and determined. At work phlegmatic are patient and persistent, but not intrusive, and they usually compensate their tardiness to diligence. [6]

The last are melancholic. They tend to be overly sensitive to the world around them, unsociable, fatigue; stressful situations make them feel confused and vulnerable. The rate of speech is always slow. Melancholic make an impression of a sad person, hesitant and shy. Emotionally these people are manageable - if the situation changes, melancholic will change along with it. At work these people are often characterized by inconstancy. They are too impressionable and too sensitive to external stressors. They are symbols of sadness, suspicion and resentment. [4], [6]

While knowing these features of each type it is easy to find a common language with the team, middle management, employees, and just different people. This knowledge will help to lead the conversation back on track, to find a common language and even control the consciousness of workers, if necessary. However, a significant disadvantage of this classification is complexity and applicable to those with whom project manager have long

business relations – like constant or inner clients. Project manager should have a lot of experience and knowledge to clarify the differences between the sanguine and choleric, for example. Therefore, we need to find something less complex.

3. Combination of character with the physical appearance

As we mentioned before client is someone who would not stay negotiating with the project team for very long time, while project manager would analyze him. You have to do everything as quick as possible. For this situation, project manager should try to simplify the previous one.

But how PM can understand who is sitting in front of him in the shortest time? There is another side of the Hippocrates method. It is an embodiment of person's character and his physiological appearance which is presented in Table 1.

Table 1. Summary of temperaments features [9], [11]

Feature	Melancholic	Choleric	Sanguine	Phlegmatic
Physique	Frail (fragile) appearance, leanness and thinness.	Frail (fragile) appearance, leanness and thinness.	Round body, massive physique, poorly developed upper limb girdle.	Square-rectangular body. Massive, dense physique.
Muscles	Long thin muscles.	Long thin muscles.	Short relief muscles.	Medium length and thickness of the muscle.
Chest	Narrow, long, flat or concave. Acute rib angle	Narrow, long, flat or concave. Acute rib angle	Short, wide, convex chest.	Short, wide, convex chest.
Skull shape	Elongated square forehead. Skull narrows from top to bottom	Oval, slightly tapering upward, cone-shaped skull.	In general is large, wide, round, and deep.	Generally short and narrow.
Neck	Mostly long and thin with no evidence of muscularity.	Long medium thick or thin.	Short thick neck.	Long with gooseneck appearance, frequently thin a protruding Adam`s apple.

If project manager has the knowledge and descriptions about the listed descriptions in Table 1, he will need to spend several minutes with the client to get the all information and analyze it. Project managers will no longer need to seek out all sides of human character, he just need to connect person's appearance to the basic phrases. For example, to confirm the phlegmatic temperament based on physiological data after the first questions the client will respond with phrases like "I would like to see a complete list of ...", "I'll wait for the written conformation ...", "Can you confirm that you said with something... ". [9]

However, if PM uses this method, he will avoid the disadvantage of time not the complexity. Accept of the main purpose of the meeting (some business and project theme) PM will have to remember all the differences and match them to the person's behavior. This aspect is a challenge, especially for not experienced project managers, which may lead project manager to confusion or incorrect conclusions.

4. Modern view on temperaments

Today, the experience of practical and theoretical literature claim that all the problems in both the main activities of the organization and the process of organizational changes associated with the human factor. Project management knowledge is not an exception. [10]

When there is an active promotion and development of the PM science and the active use of it in practice, managers are faced with many challenges. And we see that the number of project management firms is growing very quickly. This creates active competition on the market[2]. It is the client who chooses an executive company. So in order to get the right to implement the large projects and to enhance company's name, project manager has to convince new client that exactly this company is the best to work with. He has to persuade client that the work will be both effective and advantageous.

The ability to direct the conversation into the right way using the proper arguments and to have the qualitative dialogue is the key to success in creating a foundation for further development and productive relationship for both the project team and for the client. So if PM want to find a way to communicate with the client, he will have to pay the attention to client's character.

As it was already mentioned, there are many classifications of psychological dividing people on different criteria. We have identified one that can be put on project management practice. The primary source of this method is unknown, but in spite of that, many professors of psychology describe it as a simplified, but modern theory of Hippocrates on the types of temperament[8]. This classification divide people into 4 main groups [7]:

- Confident
- Aggressive
- Indifferent
- Hesitant

This method does not deny the existence of other categories, but insist on the fact that that others are advanced from main ones. If project manager can find out which type does the client refer to, he can immediately build the arguments and proposals to succeed the negotiations.

The first type is confident. This type of people as clients are the most difficult to negotiate with. The difficulty lies in the fact that his desires are so fixed that it is impossible to convince him in reverse. The only advantage for PM in this situation is when the client has a great knowledge about the product he asks - the technology, methods, understands the value of the project, all of the risks and opportunities. It will be difficult if client sees only the opportunities for the final product and he doesn't care how it would be created, which investments and resources it requires, what risks and threats it contains while implementing. The most important thing for him would be the cost of the project and he will try to reduce it, no matter how. The main task of the project manager is to bring the client to the reality.

The main idea of manipulating this type of clients is to show themselves as weak to face the problems. Client is sure about himself and project manager has doubts about his ability to solve the problems. Then, instead of the confidence, which is based on subjective capabilities, he will lose the control on the situation, while trying to convince project manager that he can do the required issues. Once, the project manager shows that he has doubts about the client's possibilities; confident client would do his best to disapprove it. While convincing others about his strength client will mainly convince himself in something project manager wants him to.

The next type is aggressive. The aggressors are explicit or implicit. With the explicit aggressors it is very simple to work - they can be seen; it is easier to cope with them, even though most people afraid of them. However, the implicit aggressive client is dangerous. Sometimes this type is confused with confident or hesitant. The main idea how to see implicit aggressor is to pay attention to his micro movements: he holds his hands in fists, hide them behind his back or even scratching the palms, intense face expressions and permanently raised shoulders. Also distance gives away these people - they try not to let others in their comfort zone. To confirm if there is an aggressor, PM should knock him out of action by asking uncontemplated question or making unexpected movement, from which he declare himself.

Aggressive clients are the same as confident ones in knowledge, but these people are trying to dominate from the first minutes of meeting. Naturally, the client will essentially dictate the rules for a particular project, but it is important for the project manager to withstand the pressure.

Fights with such people make no sense. Rising above them often leads to the end of the conversation, not in favor of the project manager. PM should not switch to higher tones; he must stay confident and calm to give the answers. This will guarantee successful negotiations with such people. As soon as the aggressive person will understand that he can’t unbalance PM he will recede as fast as possible. After the feeling that PM does not want to fight with him, the client will stand back and it will be easy to go onto the offensive and to persuade him to the required point of view.

Indifferent. This type of clients is very difficult to win over. Such people have no emotions and they will entice to the business. But the lack of emotion only means lack of energy and desire to create something, so that it will be difficult to establish co-operation both on the initial stage and the further work. Complications will appear after the first steps and agreements, when such people be uninterested in the idea of working together and achieving the goals.

The only way to direct such client in the necessary way is make him interested in the alliance. However, it is not just to make him be interested in the fact that he has already been waiting from the project team and the final product, but to show him how beneficial the cooperation on every stage will be for him. The main idea to attract such clients is to build your evidences so that they become perfect, very clear, described in numbers, but presented as confident and colorful as possible. Manipulating such indifferent mind is very important for project manager, because this client will be able to give the maximum amount of essential information on the initial phase of the project, so that the team could know all the sides of the work.

The last type is hesitant. It is wrong to think that hesitant client is the best one. What do we see at first? He agrees with project team on everything, he nods and even smiling, his eyes burn with the desire to sign the contract and start working. Nonetheless, after some time, he denies all the sets of ideas and proposals mentioned above referring to any relevant or irrelevant arguments. There are some phrases that you can hear from them: "We probably will not be able ...", "these methods are not for my company ...", "it's too hard/difficult ..", etc. You can’t bring over this person. Even more, if you begin to prove your rightness, he will inevitably leave the office in search of something easier.

The tool against such client is persuasions. Not the persuasions of client, but persuasions of project manager. It is necessary to build a dialogue so that the client himself will give advice, which project manager is waiting for. Forcing him to fight for the project is nothing more than a victory in such negotiations.

However, the main problem with this type is the recognizing. Hesitance appears only after the project manager will lay all the cards on the table. All of the arguments used, everything shown in the best colors, but smiles are gone and nods passed away. The next PM will hear are the phrases of doubts. Therefore, the best way to influence on the opinion of hesitant client is to notice loyalty and agreements with any options on time. If there are such features, project manager has to get him into conversation. If the client is softening the speech, it is our type. Hesitant will say “try to achieve” instead “we have done”, “we have some sketches, but I don’t think they might fit the project” instead “we already have a vision of this project”. If PM catches the hesitant, the problem almost solved.

Knowing all of these types and tools of negotiating project manager can not only convince the client of signing the contract with the firm, but to find common ground with him, which will

be available during the project implementing using all the resources and perform the process in more rational way.

5. Results and Conclusion

In today's world, competition in all knowledge fields increases every day. Project management is raising to the perfect level in the business sector, where each of us now have to exist in the fierce competition to attract the most promising and largest clients. Nevertheless, this field of knowledge is so versatile that being a regular leader is not enough. PM has to manage both workers under him and clients who hires him.

Many methodologies describe different ways of solving the conflicts in terms of the negotiation rules, business communication and ethics, but even following these rules may leave a negative impression on a client. Therefore, using the techniques described in this paper should help each manager to find common ground with the potential client. Client is someone who wants to work with project company, he will explain his vision, assert desires and even indirectly rule the process of creating value, but every step will be driven by his psychological preferences. This is why in order to prevent disputes, find a common language, suitable and correct way to entice him to the project manager side it is obliged to see him not only as an entrepreneur, but also as individual. While solving such problems, the complexity and diversity of the profession of project management reveals. Only best can manage with this versatile.

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INITIAL STEPS FROM CRITICAL FIELD ZO CRITICAL CHAIN

Prof. Dr. Wolfgang Tysiak

University of Applied Sciences and Arts Dortmund
Faculty of Business Administration
Emil-Figge-Straße 44
D-44227 Dortmund
Tel. 0049-(0)231-755-4996
Wolfgang.Tysiak@FH-Dortmund.de

Key words: project scheduling, risk management, PERT, Monte Carlo simulation, critical field, Iman-Conover-approach, correlated distributions, critical chain.

Abstract: Since it is quite obvious that the use of PERT to introduce uncertainties into the time management of a project evinces very severe disadvantages, the best known alternative given by Monte Carlo simulation ("critical field approach") is examined. At first we show that it is even possible to integrate correlations into the critical field approach. Afterwards we want to show that it might also be possible to enhance this method into the direction of critical chains.

1 Introduction

Since a project is said to be "a temporary endeavor undertaken to create a unique product, service, or result" (cf. [1]), there will always be the need of including some kind of risk management into project management (cf. [1], [2]). Risks in projects can occur in different dimensions, such as time, cost, quality. In this contribution we will only consider uncertainties related to time, but as everybody knows, who has experience in project management, a prolongation of a project normally will also affect its costs.
Since more than fifty years there is mostly only one method mentioned in the common textbooks about project management that should be applied to handle insecurities in the scheduling process, namely PERT (Program Evaluation and Review Technique), which has been developed by the United States Navy together with the OR department of Booz, Allen and Hamilton in the 1950s. Purpose of this development was to support the deployment of the Polaris-Submarine weapon system (cf. [1], [2], [3], [5], [6], [7]). Unfortunately because this method relies heavily on the critical path method, it entails some disadvantages. The most severe aspect that has to be mentioned is the fact that PERT systematically underestimates the real risk (cf. [8], [9]). But there is a quite powerful alternative that overcomes most of the disadvantages of PERT, the Monte Carlo simulation.

2 PERT versus Monte Carlo simulation

PERT reduces the whole stochastic scheduling model to the expected values (assuming underlying beta distributions), then solves this problem with the critical path method (CPM) and afterwards pretends to return to the stochastic approach again by adding some stochastic element – like putting the cherry on the top of a cake. This finally added stochastic element is the consideration that – according to the central limit theorem – the convolution along the critical path will approximately lead to a normal distribution and that we therefore just have to know the mean and the standard deviation along this critical path. But the problem is that in the real world there is no unique critical path. If you try to reduce the stochastic world to its expected values, you will get drowned in a lake with an average depth of 5 inches.
To make this a little more concrete, we take the following example of a project (fig. 1) with some activities, predecessor/successor relations and uncertain durations. These uncertain durations are estimated by using the popular three-point-estimation method: optimistic duration (OD), most probable duration (MD), and pessimistic duration (PD).

Activity	Predecessors	OD	MD	PD
A	-	2	3	4
B	-	3	6	9
C	-	2	5	10
D	-	4	6	9
E	A, B, C	3	7	10
F	C, D	2	7	9
G	E	2	3	4
H	E, F	3	6	8
I	F	3	5	9
J	F	2	7	10
K	G, H, I	2	6	8
L	I, J	3	5	8

Fig. 1. A fictitious project plan

According to PERT, which assumes that these three-point-estimates determine beta distributions, this will lead to the critical path shown in fig. 2, with a mean of 24.5 and a standard deviation of 2.128 for the total duration of the project (distribution shown in fig.4). One of the main problems of PERT is the fact, that unfortunately the assumption of a unique critical path is not realistic. Due to the varying durations of the individual activities, it is not the case that the activities can be divided into critical and non-critical: Each activity possesses a probability between 0 and 1 to become critical. This was already mentioned by Van Slyke as early as 1963, who called this property "criticality" (cf. [10]). Van Slyke performed a lot of Monte Carlo simulations, which at his time of course were only possible with the deployment of large mainframes. In the end we have to admit that in the case of uncertainties, there is no unique critical path, but only a "critical field".

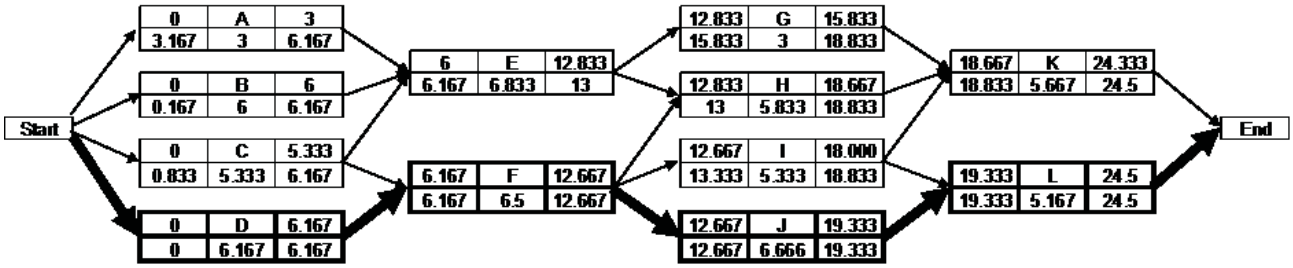

Fig. 2. The critical path due to PERT

To contrast both approaches, we perform Monte Carlo simulations with the given example and to make the results entirely comparable to the PERT approach, we use exactly the same beta distributions for the durations of the individual activities (cf. [11] for computational background). The 10,000 created cases of these simulations then lead to a variety of critical paths (fig. 3), the so-called "critical field". The dotted line in fig. 4 compares the distribution of the total duration of the project with that of the PERT result. It is obvious that the mean increased from 24.5 in the PERT approach to 26.2 in the Monte Carlo simulation, whereas the standard deviation decreased from 2.128 to 1.636. More meaningful in the context of risk management is to observe quantiles. If we look at the maximum duration that will be achieved with a probability of 95% (normally denoted as value-at-risk (VaR95)), we find that the VaR95 increased from 28.0 in the PERT approach to 28.8 in the Monte Carlo simulation. By this, it becomes obvious, that PERT underestimates the real risk. A more detailed explanation of this fact can be found in [11]. It can also be shown that this underestimation is systematical and perceivable in quite almost every project plan.

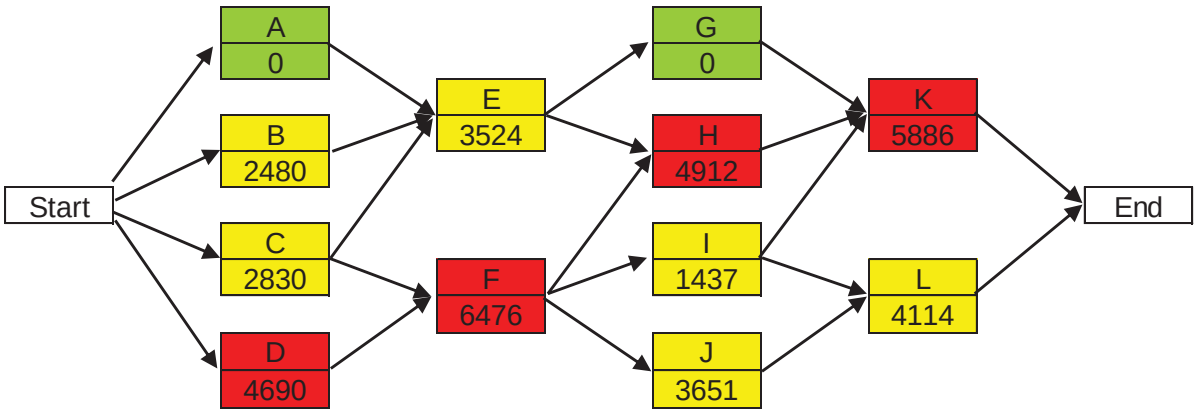

Fig. 3. The critical field (number of times that a node is critical)

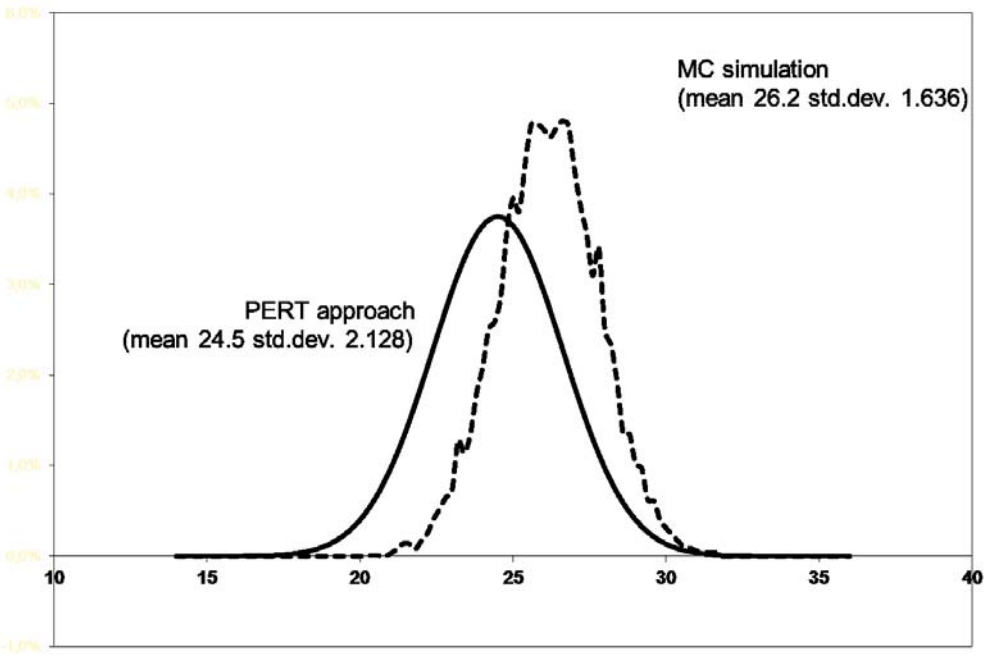

Fig. 4. Distributions of the duration according to PERT and Monte Carlo Simulation

3 Correlations of the durations

Using Monte Carlo simulation instead of PERT might provide a more realistic model to generate the distribution of the duration of a project. But there is still one rather unrealistic assumption: The independence of the distributions of the durations of the individual activities. If we look for example at a construction project. One severe risk that may occur and affect the duration of several tasks simultaneously might be the weather: If the weather is really bad, this will usually affect several tasks. Or if we fear in some other project that some tasks may last a little longer because of the qualifications and talents of the staff, then this will be the case for all the activities where this staff is involved. If you think of projects, you will easily identify reasons for dependencies/correlations between the durations of individual activities and quite seldom you can really believe that all the activities are totally independent from each other. Hence it might be interesting to introduce correlations into the Monte Carlo simulation approach. Sometimes the argument is perceived that in reality the estimation of correlations is much too difficult. On the other hand the modelling of correlations might give you an impression of their possible impacts on the resulting duration of the whole project, although you are not able to estimate them in detail and in total.

In recent years, the interest in the generation of correlated random numbers ("copulas"), that follow given distributions, rapidly increased. One main driver in this progress was certainly the need of such numbers in the vast field of simulation in finance (cf. [12], [13], [14]).

In [15] we proposed the use of the Iman/Conover (1982) technique, which is based on the well-known method to generate multivariate normal distributed random numbers that follow a given correlation matrix C. This can easily be achieved by calculating the Cholesky decomposition $C = L \times L^t$ of the given correlation matrix into a lower triangular matrix L and its transpose L^t. By multiplying the matrix of the independently generated normal distributed random numbers with the matrix L, we get the correlated normal distributed random numbers. Iman/Conover realized that correlations can easily be achieved just by reordering the existing data. Therefore they proposed for arbitrary distributions to create independent random numbers and afterwards reorder them by using the ranks according to a multivariate normal distribution with the desired correlation matrix (cf. [16]).

Especially in the case that these arbitrary distributions are quite "good-natured" and not "too different" from the normal distribution these approach works very well. Since in our application we assume beta distributions, these conditions are fulfilled quite well. That the Iman/Conover approach is really appropriate could also be verified in [15].

Let us first look at the matrix C_α (fig. 5). Here we have a correlation matrix with columns and rows that represent the 12 activities of our project in alphabetical order. The elements on the diagonal are of course equal to 1, whereas all the non-diagonal elements are assumed to be identical and equal to α. Therefore the already shown case of independency coincides with the case α = 0.

$$\boldsymbol{C_\alpha} = \begin{pmatrix} \mathbf{1} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} \\ \boldsymbol{\alpha} & \mathbf{1} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} \\ \boldsymbol{\alpha} & \boldsymbol{\alpha} & \mathbf{1} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} \\ \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \mathbf{1} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} \\ \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \mathbf{1} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} \\ \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \mathbf{1} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} \\ \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \mathbf{1} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} \\ \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \mathbf{1} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} \\ \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \mathbf{1} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} \\ \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \mathbf{1} & \boldsymbol{\alpha} & \boldsymbol{\alpha} \\ \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \mathbf{1} & \boldsymbol{\alpha} \\ \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \boldsymbol{\alpha} & \mathbf{1} \end{pmatrix} \quad \boldsymbol{C_\beta} = \begin{array}{c} \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & \boldsymbol{\beta} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \boldsymbol{\beta} & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & \boldsymbol{\beta} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & \boldsymbol{\beta} & 0 & 0 & 0 & 0 \\ 0 & 0 & \boldsymbol{\beta} & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & \boldsymbol{\beta} & 0 \\ \boldsymbol{\beta} & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & \boldsymbol{\beta} & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & \boldsymbol{\beta} & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & \boldsymbol{\beta} \\ 0 & 0 & 0 & 0 & 0 & \boldsymbol{\beta} & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \boldsymbol{\beta} & 0 & 1 \end{pmatrix} \end{array} \begin{array}{c} A \\ B \\ C \\ D \\ E \\ F \\ G \\ H \\ I \\ J \\ K \\ L \end{array}$$

Fig. 5. The matrices C_α and C_β

Let us now increase the value of α from 0 to 1. The resulting densities of our example can be found in fig. 6. For the sake of comparison, the already known density of the PERT approach is included again. It is obvious that with increasing values of α, the density becomes flatter, the tails get heavier, and the mode moves slightly a little to the left. This can also be seen if we compare the values of the mean, the standard deviation, and the VaR95 (fig. 7). We have to keep in mind that the calculation of the duration depends mostly on two operations: To calculate sums and maximums. If we look at two random variables and increase their correlation, this will not affect the mean of the sum, but the standard deviation will significantly increase, because there will be less compensations. If we look at the maximum of two variables, the increase of correlations will lead to a decrease of the mean of the maximum, because of less independency. The standard deviation of the maximum also depends on the relation of the means of the two random variables, but usually will not change it that dramatically. Referring back to the results in fig. 7, we can postulate that the slight decrease in the mean is a consequence of the maximum operations, whereas the large increase of the standard deviation can be deduced from the summations. The resulting increase of the VaR95 is due to the fact that the decrease of the mean does not compensate the increase of the standard deviation.

If we want to incorporate also negative correlations we have to bring to mind that apart from the symmetry, a correlation matrix has to be positive definite. This is equivalent to the property to possess only positive eigenvalues. This feature reflects the fact that negative correlations might lead to contradictions: If for example A and be are negative correlated as well as B and C, you cannot have negative correlations between A and C. And the above mentioned property just describes this. In practice this complicates the construction of a valid correlation matrix very much. It is much easier to create correlation matrices with positive values than with negative values. In some sense this might be seen as another validation of "Murphy's law", because in risk management, positive correlations lead to an increase of risk, whereas negative correlations reduce risk.

To take this into account, we choose the matrix C_β (fig. 5) with a lot of zero entries. Apart from the diagonal, there is only one non-zero entry per column and row. By this, a variation of β in the whole range between -1 and 1 will lead to no contradictions. Looking at the results in fig. 8 and 9, we can detect almost the same

behaviour of the mean, the standard deviation and the VaR95 as in the first example. Because the number of non-zero correlation is less, the amplitude is inferior. The only obvious difference is the fact that the mean now remains constant. This seems to be also a result of the sparsity of the matrix C_β. The main statement that follows from both examples is: Increasing correlations lead to an increase of risk but it is possible to measure their impact!

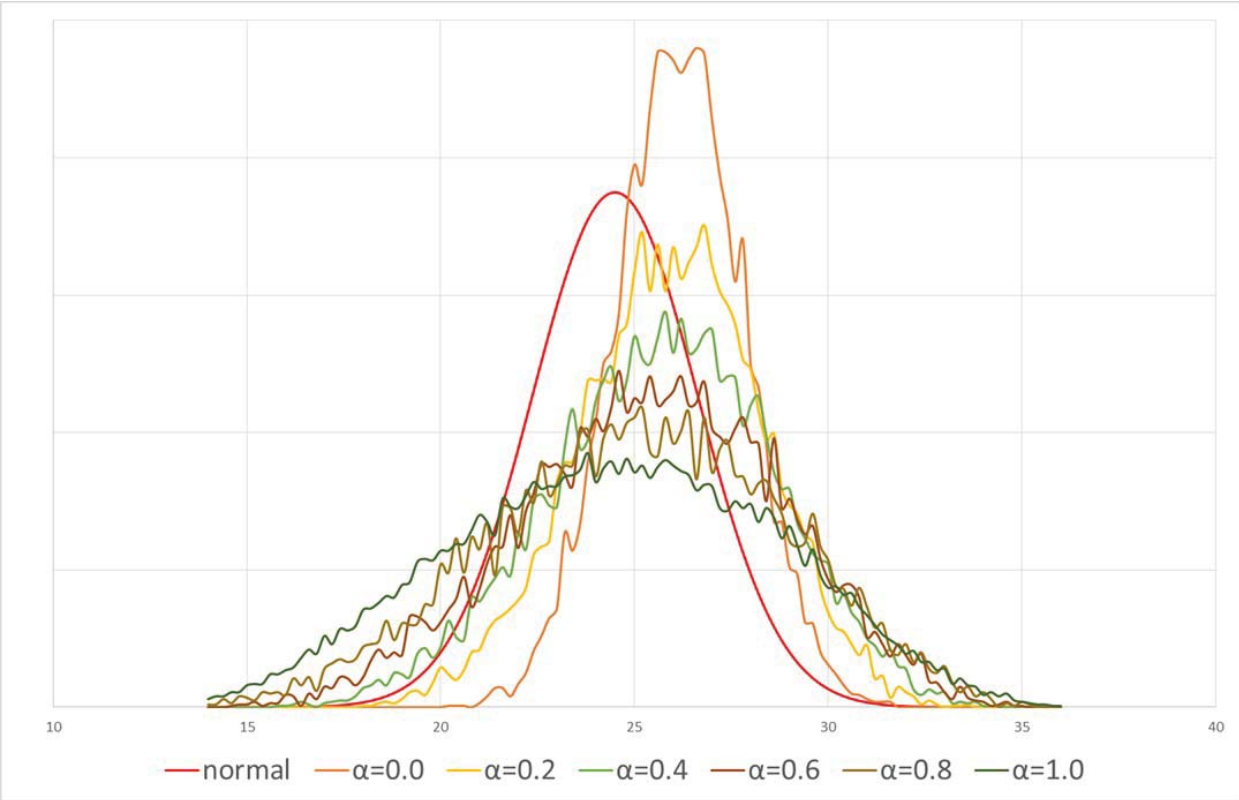

Fig. 6: The impact of positive correlations – case α

	Var95%	Std.Dev.	Mean
PERT	28.00	2.128	24.50
0.0	28.85	1.645	26.14
0.1	29.34	2.039	26.04
0.2	29.68	2.365	25.92
0.3	30.05	2.651	25.80
0.4	30.34	2.906	25.68
0.5	30.55	3.138	25.55
0.6	30.74	3.353	25.40
0.7	30.90	3.553	25.25
0.8	31.05	3.742	25.07
0.9	31.18	3.924	24.86
1.0	31.21	4.161	24.51

Fig. 7: The VaR95, standard deviations, and means depending on α

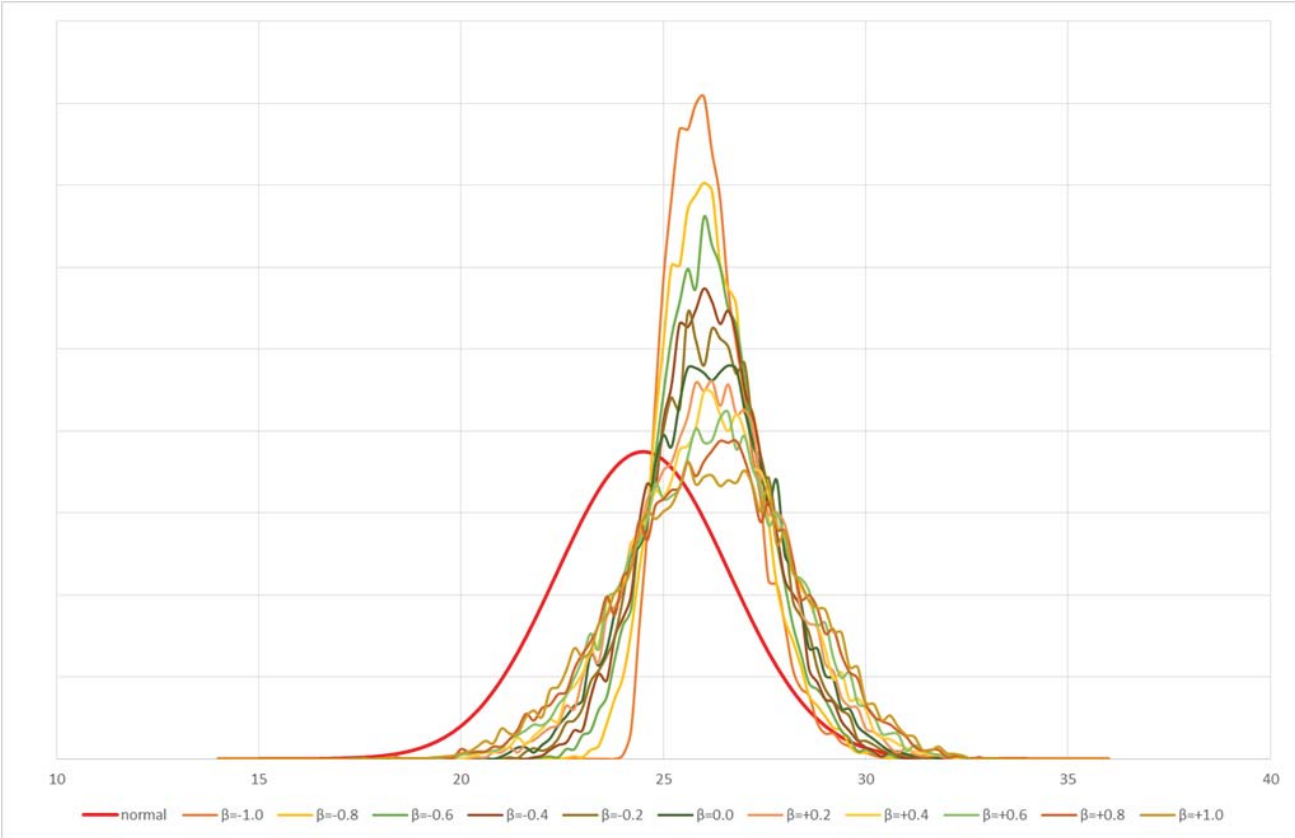

Fig. 8: The impact of positive and negative correlations – case β

β	Mean	Std.Dev.	VaR95		β	Mean	Std.Dev.	VaR95
- 1.0	26.15	1.026	28.02		0.0	26.15	1.636	28.84
- 0.9	26.14	1.095	28.11		0.1	26.14	1.703	28.93
- 0.8	26.15	1.160	28.20		0.2	26.14	1.761	29.02
- 0.7	26.15	1.225	28.25		0.3	26.14	1.817	29.10
- 0.6	26.15	1.288	28.34		0.4	26.15	1.874	29.20
- 0.5	26.15	1.349	28.42		0.5	26.15	1.931	29.31
- 0.4	26.15	1.409	28.48		0.6	26.15	1.986	29.38
- 0.3	26.15	1.469	28.57		0.7	26.15	2.041	29.47
- 0.2	26.15	1.528	28.67		0.8	26.15	2.098	29.55
- 0.1	26.15	1.586	28.75		0.9	26.15	2.152	29.62
0.0	26.15	1.636	28.84		1.0	26.15	2.201	29.69

Fig. 9. The means, standard deviations, and VaR95 depending on β

4 Critical Chain Approach

The "Critical Chain" concept is based on the book "The Goal" written by Eliyahu Goldratt and first published in 1984 (cf. [17]). The main idea is not only to regard the time management, but simultaneously also the needed resources and their availability. The provenance of Goldratt was machine scheduling in production/operations, where he introduced the theory of constraints (TOC), optimized production technology (OPT), and similar methods. Therefore he not only focused on when some task has to be performed, but also which resource is needed for it. (cf. [18], [19])

To give an impression for this, let us now assume that the activities E and F of our project need the same resources. Therefore it is impossible to work on both activities at the same time. This capacity restriction has of course tremendous consequences for the whole time management of our project. Since we only introduced

one unique resource conflict, there is only one decision to take and not a whole bunch of decisions that might lead to a lot of combinations and therefore to a decision tree. So this case is quite easy to handle.
We simulate three different ways to react to this additional restriction:
- Prio E: Activity E has always the higher priority. This means that activity E is always executed ahead of F.
- Prio F: This is the other way around: Activity F has always the higher priority.
- FCFS (F): First come, first served: The activity that can be started first is preferred. If both can be started at the same time, F gets the higher priority.

Whereas the strategies Prio E and Prio F can be realized by just changing the predecessors in the project plan (fig. 1), the third strategy means a quite different way of simulation. The results can be seen in fig.10. On the first sight it is obvious that the adding of the capacity restriction leads to a shift of the distributions. This shift has a magnitude between 5 and 6, whereas the most probable durations of the activities E and F both amount to 7. So there is some kind of compensation. On the other hand it can be seen that the shifted distributions became flatter, have heavier tails and higher standard deviations. This is exactly the same effect that could be observed in the case of increasing correlations. In some sense an additional restriction can be seen as a reduction of independency. If we compare the three shifted distributions among each other, we see that Prio F is the best strategy, followed by FCFS (F). The differences between the three strategies are quite significant, although the most probable durations are exactly the same for both activities E and F and there is only a small difference in the standard deviation (cf. fig, 1). What is more important here might be the fact that F has a much higher probability to be critical than E (cf. fig. 3).

	Var95%	Std.Dev.	Mean
Prio E	35.92	2.20	32.38
Prio F	34.98	2.28	31.30
FCFS (F)	35.46	2.28	31.78

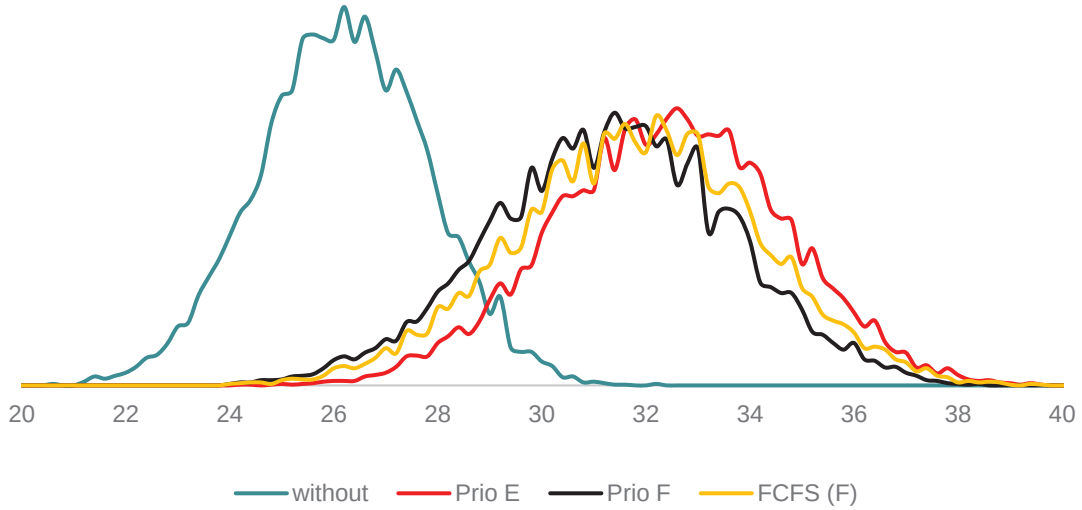

Fig. 10. Results of the critical chain approach

It is noteworthy that in our example the introduction of an additional restriction led to priority rules, which are the main tools in machine scheduling – the starting point of Goldratt's deliberations. In some sense we can say that the circle closes here.
It shall also be mentioned that we are able to get even more detailed information in this combination of the critical chain and critical field approach, e.g. the distribution of the available buffers of the individual activities. This works fully analogue as it has been shown in [9].
All the simulations in this paper have been performed with pure Excel. But for the generation of Monte Carlo simulation models that combine the critical chain and the critical field approach this is no longer reasonable. We get different layers for the durations and for the resources with a lot of logical interconnections. Therefore we need a diverse programming approach. For this reason, we could only show these very first steps from the critical field to the critical chain.

5 Conclusion and Remarks

The Monte Carlo approach offers a lot of capabilities to get deeper insights in the structure of a project. Even correlations of the durations of the different activities can be managed. If we want to include also the resources that are needed for the individual activities ("critical chain approach") we have to face a complex technical/programming challenge. But the first results stir up the hope that this is worthwhile.

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Business culture as a source of comedy: *The Office* (UK)

Henri de Jongste

Henri.dejongste@fh-dortmund.de
FH Dortmund

Keywords: business culture, national culture, situational context, social role, leadership, comedy

Abstract:
A number of scenes from the British situational comedy *The Office* will be analysed to show how they make use of underlying shared British/English notions concerning leadership and social roles (office manager) and of the situational context in which the (inter-)action takes place, namely the office of a paper merchant in Slough, England. Studies of British/English business culture will be applied to the discourse in the sitcom to see how the findings of such studies relate to the main character's behaviour as it is shown in the comedy.

1. Introduction

The concept of a national (business) culture is not uncontroversial. At the same time, creators of TV comedy heavily depend on pre-conceived cultural knowledge shared with their audience for their messages to be understood. They need to communicate with a mass audience a-synchronically and via a one-way channel, and this means that they cannot engage in the usual negotiation processes with their audience to jointly establish meaning, as described by Arundale (1999; 2008; 2012), Clark (Clark, 1996; Clark and Krych, 2004) and many others.

The British situational comedy *The Office* (2001-2003) is a mock documentary situated in the regional office of a paper merchant in Slough, England, whose central comic character is the office manager, David Brent. Aspects of the British/English business culture, in particular, notions of leadership, are consequently a frame of reference that the producers can deploy to create recognisable comedy for a national audience. Analysing the first five scenes of the sitcom gives us an opportunity of assessing how nationally shared notions of effective and appropriate leadership are used to create comedy which is understandable at a national level.

2. Methodology

In the presentation, studies of British/English management culture from the GLOBE project (Booth, 2007), as well as from classical studies such as those by Hofstede and his colleagues (Hofstede, 1980, 1991; Hofstede, 2001; Hofstede et al., 2010) will be cited to assess what the culturally shared views of management and leadership are in Great Briatin/England, and how Brent's behaviour as a manager in the sitcom relates to the findings of such studies. Using Matsumoto's model of situational contexts (Matsumoto, 2007), the potentially relevant aspects of such contexts, and consequently of the scenes in the sitcom, can be systematically analysed.

3. Culture and leadership roles

Culturally shared notions such as poly-chronic and mono-chronic time (Hall, 1959) and power distance (Hofstede et al., 2010) lead to accepted behavioural norms regarding management roles in specific communities (also see Chhokar et al., 2007). Studying *The Office* helps to explain how the cultural norms connected to these aspects are exploited in *The Office*. This is done by showing how the comedy is grounded in character behaviour which deviates from the norm and from the established patterns, and how by displaying the consequences of such deviant behaviour recognisable comic effects can be achieved.

4. Results and Conclusion

The first five scenes of *The Office*, which set the tone for the rest of the comedy, appear to refer very closely to the characterisation of the British/English business culture found in the literature and to the situational context model, proposed by Matsumoto. This strongly suggests that descriptions of British/English national business culture indeed reflect culturally shared notions of leadership, and so these findings support the view that such notions of a business culture shared on a national level are valid in the case of Great Britain/England.

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CHALLENGES IN MANAGEMENT OF RESEARCH & TECHNOLOGICAL DEVELOPMENT (RTD) PROJECTS WITHIN EUROPEAN FRAMEWORK PROGRAMMES

Ala Nuseibah

ala.nuseibah@fh-dortmund.de
Dortmund University of Applied Sciences and Arts
Emil-Figge-Str. 42, 44227, Dortmund, Germany

Keywords: European framework programmes, RTD, project management,

Abstract

In time of increasing global socioeconomic challenges, creating means to enable technological development and innovation that address the societal, environmental and economic needs becomes inevitable. According to the European Commission, research is the key element to overcome this [8] [9]. Since the launch of the first European Framework Programme (FP1) in 1984, interest of the scientific community and of research and academic institutes in studying different aspects of research management intensified. This interest culminated during and after the launch of FP6 which started in 2002 and continues up to this date after the launch of Horizon 2020 with a budget of 80 billion Euros [4] [5] [8] [9] [10] [15].

Despite all of that, analysis of the literature concerned with this topic of the past decade shows on the first glance a gap in theoretical study of research projects from a project management point of view. This should exceed the traditional project management thinking to include the analysis of the peculiarities of a research project, the understanding of its success innovative short-term and long-term measures and recognising the project proposal writing as a significant project phase with its own challenges requiring customized processes and tools. Brocke & Lippe (2015) [2] suggest that research projects have been well-researched from a process management and project management point of view [6] [12] [13] [14], but that the practical application of this knowledge and of the project management methods suggested fails [1] [2] [3] [14]. This shortcoming is also confirmed outside the scientific community, by the organisation leading these efforts: the European Commission [7] [11].

The on-going research aims to analyse the challenges to the project management of research projects within the European Framework programmes. The work is only concerned with publications about applied research over the past fifteen years. The analysis will take place in light of the existing literature, focussing mainly on publications in seven scientific journals concerned with project management and the specific research of interest. These journals are:

- International Journal of Project Management
- Project Management Journal
- Journal of Technology Transfer
- Technovation
- R&D Management
- Research Policy
- Research Evaluation

The results will be collected and further disseminated. In addition, for the purpose of reflecting on the gap between the suggested methods and the practical implications, the results will be

aligned and compared to the methods, process and gaps identified by the publications of the European Commission.

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Measurement of Efficiency of International Multinational Projects

P. Arras[1], D. Van Merode [2], G. Tabunshchyk [3]

[1] Dr. ing., International Relations Officer, KU Leuven – faculty of engineering technology, J. De Nayerlaan 5, Sint-Katelijne Waver, Belgium, peter.arras@kuleuven.be, iiw.kuleuven.be

[2] Ing, Msc, International Relations Officer, Thomas More Mechelen-Antwerpen, , J. De Nayerlaan 5, Sint-Katelijne Waver, Belgium, dirk.vanmerode@thomasmore.be,

[3] Prof. of Software Tools Department, Zaporizhzhya National Technical University, Zhukovskogo, 64, Zaporizhzhya, Ukraine, galina.tabunshchik@gmail.com

Abstract:

In international projects it is quite difficult to estimate the efficiency because of different risk factors involved. In this article authors suggest an approach for project efficiency assessment based on Data Envelopment Analysis (DEA) and its implementation for two international projects funded by the European Union "Modernization of two cycles (MA, BA) of competence-based curricula in Material Engineering according to the best experience of Bologna Process" (MMATENG, 543994-TEMPUS-1-2013-1-BE-TEMPUS-JPCR) and "Development of Embedded System Courses with implementation of Innovative Virtual approaches for Integration of Research, Education and Production in UA, GE, AM", (DESIRE, 544091-TEMPUS-1-2013-1-BE-TEMPUS-JPCR).

Key words

Data Envelopment Analysis (DEA), Tempus MMATENG, Tempus DESIRE, midterm report, efficiency

1. Introduction

There are different approaches for measuring the efficiency of different technical and social systems. Data Envelopment Analysis (DEA) is well-known and one of the most successful operational research techniques. It was specifically designed to measure the efficiency of complex entities like bank branches, schools, game players and teams.

The aim of this work to show the possibility of implementation of DEA for the measurement the efficiency of international projects like Tempus/Erasmus+.

In international projects it is difficult to measure efficiency as there are no strict scales on which to measure because of the differences in cultural traditions, different project risks and etc.

The guidelines for the international projects – subsidized by EACEA - is a very extended bookwork which describes exactly what Europe wants in a project. However, it is not a practical guide for the project manager. The project management of this kind of multi-national/multi-cultural projects with faraway partners and stakeholders in a non-commercial setting (to be read as not driven by profit as an intrinsic motivator) is in need of specific tools and processes.

For the midterm report - at half the life time of the project – a Grant Holder (project coordinator) should have a reliable tool for the assessment of the efficiency of the project to make the project successfully run up to the end. This tool can be based on the data gotten from the midterm report.

2. Measurement of Project Efficiency

Efficiency, in the economic sense, is defined as the ratio of output and input. Inputs generally refers to resources such as labor, raw materials and capital. Outputs are items produced from these inputs as a result of the transformation process that occurs within the DMU (Decision Making Unit).

If the greatest possible output per unit of input is achieved, a state of absolute or optimum efficiency has been achieved and it is not possible to become more efficient without new technology or other changes in the production process.

$$Efficiency = \frac{weighted\ sum\ of\ outputs}{weighted\ sum\ of\ inputs}.$$

Objective function for DEA:

$$Maximize\ \theta = \frac{\sum_{r=1}^{s} u_r y_{r0}}{\sum_{i=1}^{n} v_i x_{i0}},$$

where θ - efficiency rating of the service unit being evaluated by DEA, y_{rj} - amount of output *r* used by service unit j; x_{ij} - amount of input / used by service unit j; i - number of inputs used by the DMUs; *r*- number of outputs generated by the DMUs; u_r – coefficient or weight assigned by DEA to output r, v_i = coefficient or weight assigned by DEA to input *i*.

$$DMU_1 \quad \frac{\sum_{r=1}^{s} u_r y_{r1}}{\sum_{i=1}^{m} v_i x_{i1}} \leq 1$$
$$DMU_j \quad \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1$$
$$u_1, \dots, u_s > 0;\ v_1, \dots, v_m \geq 0$$

where j - number of decision making unit (DMU) being compared in the DEA analysis; DMUj - service unit number j.
Further we will consider how DEA can be applied to the assessment of Tempus/Erasmus projects efficiency.

3. Methodology for Efficiency assessment

DEA is a tool for monitoring the organizational performance. It defines an organization as a Decision Making Unit or DMU. In that an organization takes certain inputs and transforms them into outputs.
In Tempus/Erasmus+ project such DMU can be a Partner University.

One of a cases we have a look at tempus MMATENG [3]. MMATENG is an educational project aimed at improving the teaching of material sciences in the partner universities. For this a number of new course materials and curricula are developed to be used in the partner universities. Also equipment is foreseen to use in the students labs. Two extra outcomes is foreseen in the project: the establishment of MILT (Materials Information Technology Labs) for students and MESO (Material Engineering Service Office), for collaboration with industry, in each partner university. To train teaching staff of the partner universities in using the MILT-equipment and the new courses materials, a number of mobility is foreseen: training courses in the western European partner universities and master classes and train-the-trainer sessions in the program countries. The project is considered to be successful if the partner universities will implement the developed course materials into their own curricula, and if the stakeholders (society, companies, students, teachers) are informed about the project and are using the MILTs and MESOs.

Another tempus project which was analyzed was DESIRE [4]. The goal is to develop relevant and up-to-date course material, deliver supporting hardware for a physical embedded systems laboratory, virtual and remote laboratories, to train the teachers both in the EU and at their own home institution and run a pilot teaching period with the new material to assess the results. All this is done with an elaborate quality scheme, decent management and with ample dissemination of the intermediate and final results. The consortium of EU universities consists of Thomas More Mechelen-Antwerpen University College (TMMA), Ilmenau University of Technology (IUT), Constantine the Philosopher University in Nitra (UKF) providing a mutual practical-oriented approach in teaching in the sphere of embedded system. All bring in specific expertise in the project. TMMA will provide courses and deliver lab-infrastructure for embedded software and CAD/CAM/CAE, IUT will focus on embedded hardware, remote and virtual laboratories, UKF will highlight the pedagogical side on teaching

engineering courses, quality assurance and transferable skills. Implementation of all curricula requires a lot of work from partners, so it is quite important to monitor the current state and disseminate the best practice for the other partners.

As both projects are curricula reform input and output data were chosen the same. For the DEA we define the input data for each partner: actual payed staff costs; actual total time spend for each WP; time payed by Tempus; number of mobility; costs of mobility; actual costs spent on the equipment; actual other costs; indirect costs and non-illegible costs.

Measurable output data: number of staff participated in activities; number of students participated in activities; number new of courses developed; number of dissemination materials; level of Satisfaction of the staff; level of Satisfaction of the students, MILT and MESO usage.

For example we can consider as input: sum(Staff Costs and Mobility Costs), as output we can consider the number of staff involved in the activities and number of courses selected for modification (as this project refers to curricula reform).
For the DEA-analysis as output there were chosen the number of staff, which took part in the project activities, the number of modified courses/modules and the number of outcomes.
As input there were chosen the sum of staff costs and mobility costs, and costs of equipment. All data were selected by the time of midterm report (table 1, table 2), after 18 month in the lifetime of the project.

Table 1. MMATENG DEA Data for partner countries only

	Outputs			Inputs		Weighted		
DMU	N Staff	N modules	N materials	Costs (1000 euro)	Eq. Cost (1000 euro)	Output	Input	Efficiency
P1	4	3	7	7,40	1,20	1,0000	1,0000	1,0000
P2	4	2	3	3,10	1,20	0,8381	0,8381	1,0000
P3	5	0	6	1,90	26,04	1,1387	15,7267	0,0724
P4	4	5	7	12,80	25,90	1,0000	16,0529	0,0623
P5	4	14	8	17,10	11,31	1,0405	7,4433	0,1398
P6	5	10	7	10,05	18,87	1,1792	11,7229	0,1006
P7	6	10	5	15,19	23,38	1,2774	14,6278	0,0873
P8	5	12	13	21,01	1,20	1,4220	1,5123	0,9403
P9	4	10	7	8,11	1,20	1,0000	1,0267	0,9740
P10	5	33	9	14,31	1,20	1,2601	1,2601	1,0000
P11	3	10	10	17,11	1,20	0,9422	1,3655	0,6900

Table 2. DESIRE DEA Data for partner countries only

	Outputs			Inputs		Weighted		
DMU	N Staff	N modules	N materials	Costs (1000 euro)	Eq. Cost (1000 euro)	Output	Input	Efficiency
P1	8	8	18	10,32	19,07	1,0000	1,0000	1,0000
P2	13	8	8	8,00	19,17	0,7766	0,7766	1,0000
P3	8	3	3	9,16	22,70	0,4011	0,8878	0,4518
P4	7	7	7	6,98	2,40	0,5256	0,6766	0,7769
P5	12	5	5	8,80	10,67	0,6216	0,8530	0,7287
P6	4	6	6	7,09	17,75	0,3802	0,6869	0,5536
P7	5	7	7	8,27	17,89	0,4553	0,8017	0,5680
P8	4	2	2	4,00	0	0,2205	0,3879	0,5684

For both projects an analysis was made. Analysis for the DESIRE showed that three partners are less efficient than other. But analysis also showed that in general all partners results are proportional to the inputs, and only one partner should improve its key indicators.
For MMATENG the results of the analysis can't be implemented to the whole project to provide one common recommendation. So it was decided to apply it for the partners within one country and to compare per country. In this scenario there were found one weak partner in each country, for which input highly exceed output, and who need additional control measures. The problems in the MMATENG project come from the nature of being a multi-region project with Russian, Ukrainian and Israeli partners. Due to the political situation with RU-UA it was impossible to have the same levels of inputs costs by the time of the midterm report.

It should be noted that the numbers taken are a one-moment overview only. Any increase for certain partners in actions or staff involved will immediately change the results. It is advised to do the DEA at more moments in time in the project and look at the trends instead of a one-moment calculation.
Accurate data collection is a prerequisite for this technique.
By evaluating all partners at the time of the intermediate report, there was time left till the end of the project to raise the level of efficiency in the partners which performed poorly.

4. Conclusion

The analysis of efficiency of the different teams in the international projects was done based on data from the intermediate reports. Using DEA allows to find the most/lesser efficient partners and learn from their good practices and failures. As such it provides input for corrective actions in the project by sharing good practices to the other partners.
In multinational projects it can also be shown what country is overall more efficient for improving the project results.
As a management tool international projects DEA is used to evaluate what partner in the project is working more efficient, to learn from them good practices for the other partners.
It is advised to do the DEA at more moments in time in the project and look at the trends instead of a one-moment calculation. Accurate data collection is a prerequisite for this technique.
The DEA analysis proved that for different regions the same recommendations for improvement can't be applied. The methodology should be modified by including risk factors, particular for each partner country.

5. Acknowledgement

The work was done within the framework of Tempus projects "Modernization of two cycles (MA, BA) of competence-based curricula in Material Engineering according to the best experience of Bologna Process" (543994-TEMPUS-1-2013-1-BE-TEMPUS JPCR) [3] and "Development of Embedded System Courses with implementation of Innovative Virtual approaches for Integration of Research, Education and Production in UA, GE, AM", (544091-TEMPUS-1-2013-1-BE-TEMPUS-JPCR) **Fout! Verwijzingsbron niet gevonden.**

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Development of Self-configuring Systems: A Case Study

Fabian Kneer and Erik Kamsties

Dortmund University of Applied Sciences and Arts,
Emil-Figge-Str. 42, 44227 Dortmund, Germany
{fabian.kneer,
erik.kamsties}@fh-dortmund.de
http://www.fh-dortmund.de/

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1 Introduction

The Internet of Things (IoT) is a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies [3]. A *thing* is an object of the physical world (physical things) or the information world (virtual things), which is capable of being identified and integrated into communication networks. A *device* is a piece of equipment with the mandatory capabilities of communication and the optional capabilities of sensing, actuation, data capture, data storage, and data processing. One key concern of systems operating in the IoT is to dynamically adapt to changing environments, due uncertainties during requirements-, design-, and run-time.

A considerable number of concepts for self-configuring systems (SCS) has been developed. From a practitioner's perspective, *open source* implementations of the MAPE feedback loop (IBM [1]) for prototyping purposes are missing. This is a show-stopper in practice, as a practitioner would need to work through research papers in order to build such a prototype. A researcher who is interested in the comparison, extension and/or application of existing solutions to a new domain is in a similar situation.

We suggested a *prototyping and evaluation framework* for self-adaptive systems in [2]. The goal of the framework is to ease the prototyping (and possibly development) of self-configuring systems. For this purpose, the framework offers implementations of selected approaches to SCS based on the MAPE loop (e.g., based on feature models as suggested by Pascual et al. [4]). Another goal of the framework is to ease the evaluation of self-configuring systems, to allow for instance benchmarks between different approaches. For this purpose, we developed a case study drawn from the *smart city* domain. The framework is able to collect data on a subset of the metrics at runtime about overall quality, effort, and cost.

In this paper, a case study for *Smart Street Lighting* will be presented as an example of a self-configuring system developed using the above-mentioned

prototyping framework. The following section reports on the construction of the case study and the simulation. Section 3 presents the results and the future work.

2 Case Study

Domain. The *Smart City* domain is selected as an instantiation of the Internet of Things. The *Smart Street Lighting* is selected as a subdomain to start with. It is accessible to many readers, it is complex, and comprises many different facets.

Street lights become an important part of smart cities. The lights are extended with new functions beyond the usual function of providing light to a place: the lights are equipped with increasing computing power and communication capabilities like wireless connection, digital street signs, and sensors to measure their environment.

An example for a smart light is provided by the company *Illuminating concepts*[1]. They have designed a flexible wireless solution that is called *Intellistreets*, which includes a energy efficient lighting, audio, digital signage, and more. Fig. 1 shows the design of the solution. The light can communicate with other systems and also with humans to help finding a way or send an emergency calls. Also the audio and digital signage can be used for entertainment or announcements.

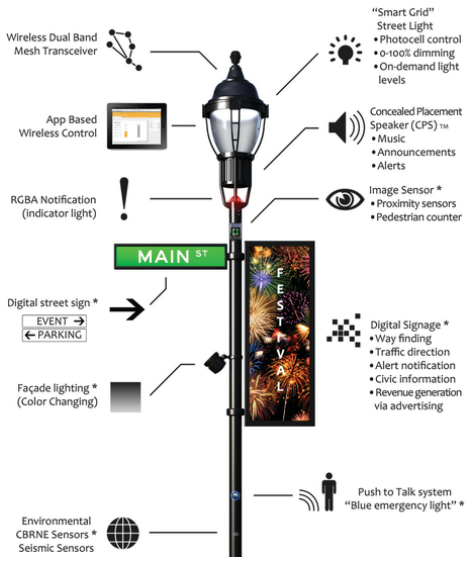

Fig. 1. Intellistreets solution developed by *Illumination concepts* [2].

[1] www.illuminatingconcepts.com
[2] See footnote 3

Further, more companies like *Siemens*[3] are producing parking management systems. The lights have sensors like distance and movement to detect parking vehicles under a light. This information is used to inform driver who are searching for a parking slot. The information about a free or used parking slot is sent to the traffic control center and also to parking services and apps. The car driver can be informed by navigation systems, smart phones, or over the previously shown digital signage of a smart street light.

Specification of the Smart Street Light case study.

The development artifacts of the prototype are developed in a tree structure. The context is *Smart City*, the system is *Public Lighting*, and the subsystem *Smart Street Light*. For the *Smart Street Light* a *Prototype Configuration* is needed. This configuration contains the development artifacts that are chosen for the prototype (e.g. feature model, utility table, and event-condition-action rules (ECAs)). The artifacts are described in a *Software Requirements document*.

The development artifacts are used by a *Generator* to produce source code of a prototype.

In the remainder of the section, the development artifacts that describe the self-configuration of the street lamp are shown. The artifacts are used to generate parts of the self-configuration framework and the probes for the application.

Feature Model. Fig. 2 shows the feature model for the street light are shown. The feature model is modeled using the prototyping framework. The different realization strategies are developed as variation points in the model.

The lamp can adapt its luminous color and illumination. The possible values for these parameter are represented as alternative group (Xor-Group) in the feature model. The possible colors are white, blue, and red. The illumination is shown in percent and can variate between 0%, 20% and 100%.

The *abstract Sensors* of a street light are *Twilight* to measure light, *Distance* to measure if an object is under the light, *Movement* to react to moves near the light and *Hydro* for weather information.

The lamp can choose between the following three different options to light the street:

- *Always On*: is a error state that results in a street light with maximal illumination. (See constraints: *Always On requires 100*)
- *Timed Lighting*: the light is on during a given time interval. This feature needs a timer to react and activate the light (see constraints). This feature can variate between *Static* and *Dynamic* mode. *Static* leads to a 100% illumination during the interval and *dynamic* reacts to movements by switching between 20% and 100% illumination.
- *Light-controlled Lighting*: this feature requires a *Movement* and a *Twilight* sensor. If the twilight sensor indicate a need for light, the light is put on. Like the dynamic mode of the *Timed Lighting* feature, the light-controlled feature reacts to the movement sensor by switching between 20% and 100% illumination.

[3] www.siemens.com

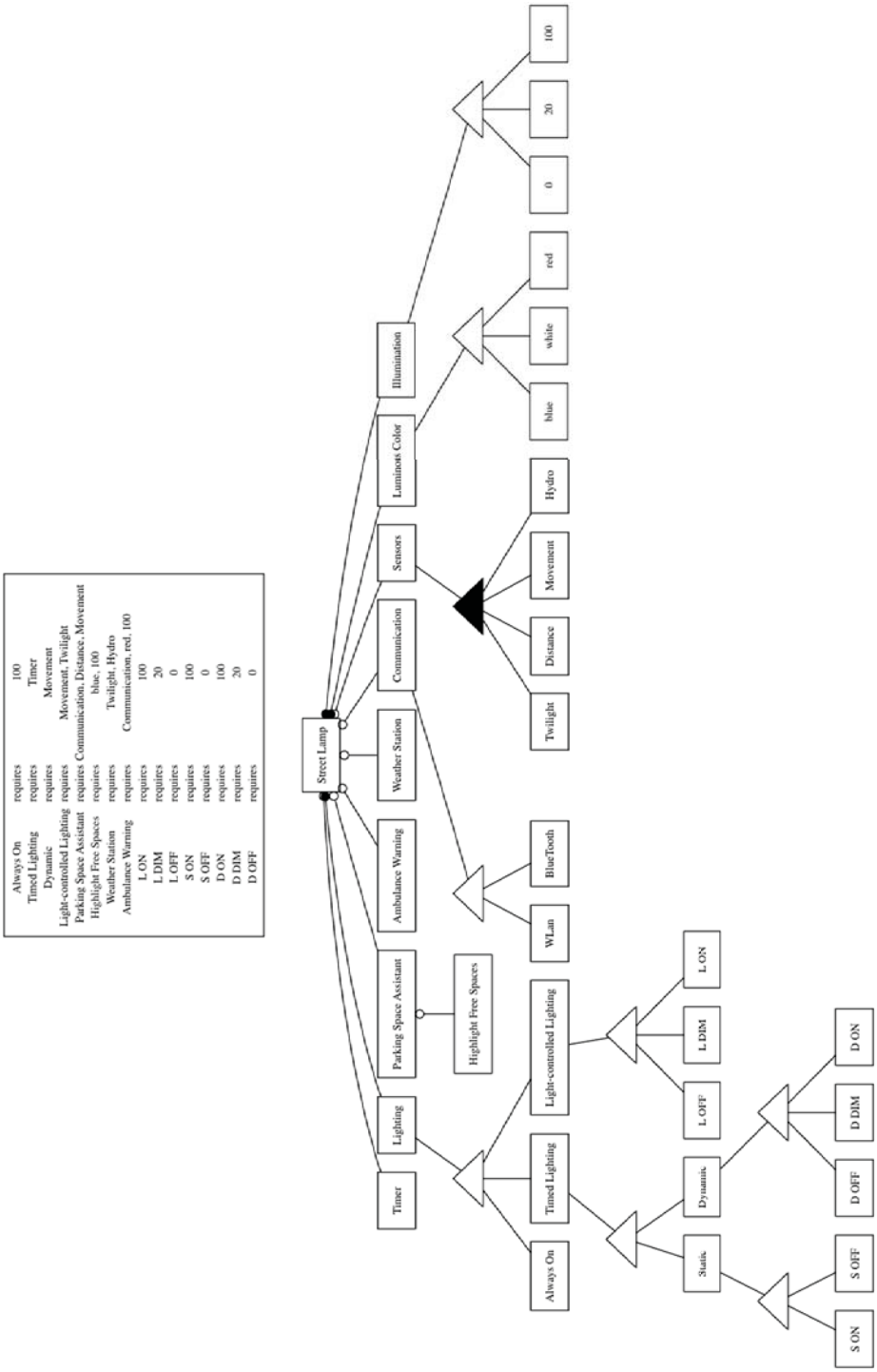

Fig. 2. Feature Model of a Public Street Light.

The next feature is *Parking Space Assistant*. This feature sends information about the free parking spaces under the street light to connected systems like navigation system and also *Highlight Free Spaces* with a blue luminous color.

The last feature is *Ambulance Warning*. If the lamp has an established connection, it gets information about ambulances that pass the street light. The lamp reacts and try to warn its environment by switching to a red luminous color.

Indicators. The case study has status indicator for sensors of the systems, e.g. movement sensor. A boolean value shows if the sensor works as expected or deliver wrong values. In addition to the status indicators, the following indicators are defined:

- `ambulance` shows if an ambulance will pass the street light.
- `detectTwilight` shows a change of the daylight.
- `cars` shows the number of parking cars under the street light.
- `searchingCar` shows if a driver near the street light search for a free parking space.
- `detectMovement` shows if a person or car moves near the street light.

The next three indicators represent the time values of the street light. These are the current system time (`time`), a parameter when the street light should be turned on (`turnOnTime`), and a parameter when the street light should be turned off (`turnOffTime`).

Simulation. Both the application and the framework are generated as a console application and they need a GUI. Fig. 3 shows the GUI for the application. On the left side of the screen-shot, the software simulation of the previously presented street light is shown. On the right side, the configurable values are shown. The first values represent the time indicators (*currentTime*, *turnOffTime*, and *turnOnTime*). The next values represent the status of the sensors. A defect sensor is colored *red*. In this example screen-shot, all sensors are working correctly, which results in green colored sensors. The two buttons with the image of vehicles, can be used to start a moving vehicle (ambulance in the example screen shot). The last configurable values are *parking cars*. Next to the parking symbol are the buttons + and -. Up to three cars can be added to the parking spaces under the street light.

The progress bar and the *Go* button are used to represent and start a scenario. A scenario represents a day of the street light with random events, which are produced during this interval.

Fig. 4 shows a screen-shot of the prototypical GUI for the self-configuring street light. The left table represents the feature model. The *selected* features in the current configuration are colored green and the *deselected* are colored gray. The right table is the utility table. The rows represent a utility element with the utility values and the resource costs.

In the given example, the street light notices a passing ambulance and switches to a configuration with a red light color and maximum illumination.

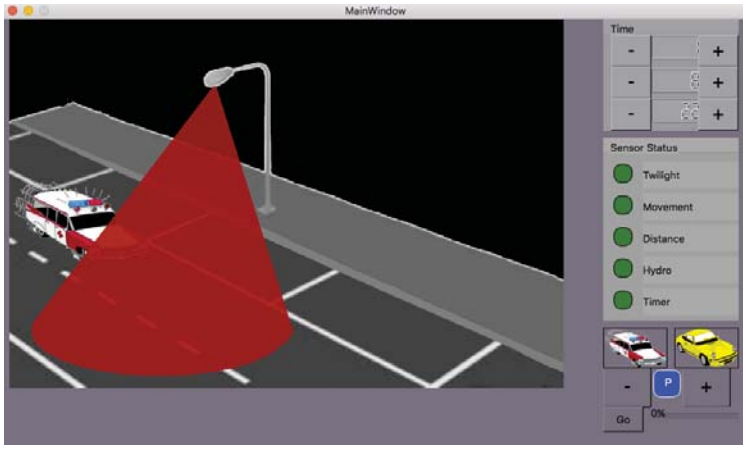

Fig. 3. GUI of the simulated Street Light.

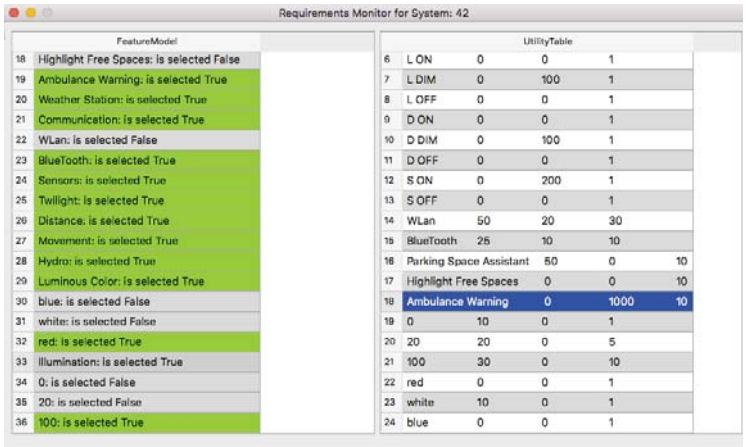

Fig. 4. GUI of the Feature-based Prototype.

3 Results and Conclusion

This paper presented a case study in which a self-configuring system - a smart street light - was developed using a prototyping framework (developed by the authors in previous work). The case itself can be used by a requirements engineer to validate approaches from the area of self-configuration that are integrated in the framework. The case study is taken from a subdomain of the smart city domain as an instantiation of the Internet of Things. The case study is scalable and can be extended by additional systems or features of the street light, for example, more lights or a public utility system that is connected to the street lights.

The framework for prototyping and evaluation can be used in a number of ways on the given case study:

- to *understand* a particular SCS approach,
- to *optimize* the application of an approach, or
- to *compare* approaches in a particular target environment.

At the time of writing we have developed a software simulation and a prototype of a hardware street light. To enlarge the case study, a RC-car is under development, which enriches for instance the parking scenario. Also part of our future work is to build a small street model with up to five street lights, which can be connected to a virtual simulation of a smart city.

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Complexity Reduction via Hierarchical Product Structures in the Field of Automotive Demand and Capacity Management

Daniel Fruhner[1], Konrad Pawlikowski[2], Katja Klingebiel[1], Michael Toth[2] , Axel Wagenitz[3]

daniel.fruhner@fh-dortmund.de, konrad.pawlikowski@hs-bochum.de, katja.klingebiel@fh-dortmund.de, michael.toth@hs-bochum.de, axel.wagenitz@haw-hamburg.de

[1]Dortmund University of Applied Sciences and Arts, Otto-Hahn-Str. 23, 44139 Dortmund, Germany
[2]Bochum University of Applied Sciences, Lennershofstraße 140, 44801 Bochum, Germany
[3]Hamburg University of Applied Sciences, Berliner Tor 5, 20099 Hamburg, Germany

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Abstract:
An integral component of the automotive supply chain management is the demand and capacity management (DCM). DCM synchronizes resource requirements, resulting from future or already realized market demands, with capacities and restrictions of the supply chain and production system. The uncertainty and volatility of the market demands is one major challenge of the DCM, other challenges are product variety and supply chain complexity. An efficient data management can increase transparency immensely and thus support the DCM processes effectively. This contribution analyses the integration of distributed product data into hierarchical tree structures against the background of complexity reduction. The analysis is based on data from a German automotive manufacturer extracted from the decision support system OTD-DCM.

1. Introduction

Automobile manufacturers (original equipment manufacturers, OEMs) tend to offer their customers buying incentives to compete in international markets. Therefore a huge variety of models is offered that can be further individualized by several hundred options, i.e. colors, assistance systems, etc. Moreover, OEMs constantly update their product range in an increasing frequency (Schuberthan and Potrafke, 2007, p. 9). Though, customers have to deal with the variety of models, they tend to expect that the produced car is rapidly delivered on the planned date, but also that vehicle orders can still be customized shortly before actual production (Alford et al. 2000, p. 100; Krog and Statkevich 2008, p. 187).
Here, logistics plays a significant role. Suppliers do not only produce simple components, but also develop complex modules (Trojan 2007, p. 12). Product marketing, assembly of supplied parts, the coordination of suppliers, and the distribution of the end product are the new competences of the OEM (Meißner 2009, p. 1). For the car manufacturer, the integrated management of the automotive production and supply chain is critical. Therefore, the integrated and coordinated capacity planning, the timely derivation of resource and component requirements as well as anticipation of the future market demand are essential requirements (Yu-Lee 2002, p. 3). Most critical, resource requirements resulting from anticipated or realized market demand need to be synchronized with resource capacities and restrictions of the production and procurement system by an effective demand and capacity management (DCM). DCM processes identify demand- and capacity-asynchronies and timely implement appropriate countermeasures. DCM acts as an essential interface between market, production and supply chain processes (Krog et al. 2002, p. 47; Arnold et al. 2008, p. 472). Though, as customers can choose from billions of possible configurations for each car type, it is hardly possible to predict the exact future vehicle orders. Nowadays, a prediction of sales volumes for the car models offered in the different sales regions (e.g. sum of Audi A4 Avant 2.0 TDI) and sales quotas for the selectable options (e.g. ratio of

vehicle with parking sensors or head-up display) are executed by the sales departments of the OEM. A complex set of technical rules describes the compatibility of options for a respective vehicle, while the bill of material (BOM) describes the relationship between the fully-configured car type and the corresponding parts. As indicated in Figure 1, capacity restrictions and constraints exist on production level, sales level and supply chain level.
Bridging the gap between demand information and capacity information is necessary to balance volumes and quotas with constraints and restrictions in order to find bottlenecks (Stäblein 2008; Zernechel 2007, p. 372; Gebhardt et al. 2003, p. 1ff). This task is complicated by demand volatility, forecast uncertainty, changes in the supply chain and rapid product changes.

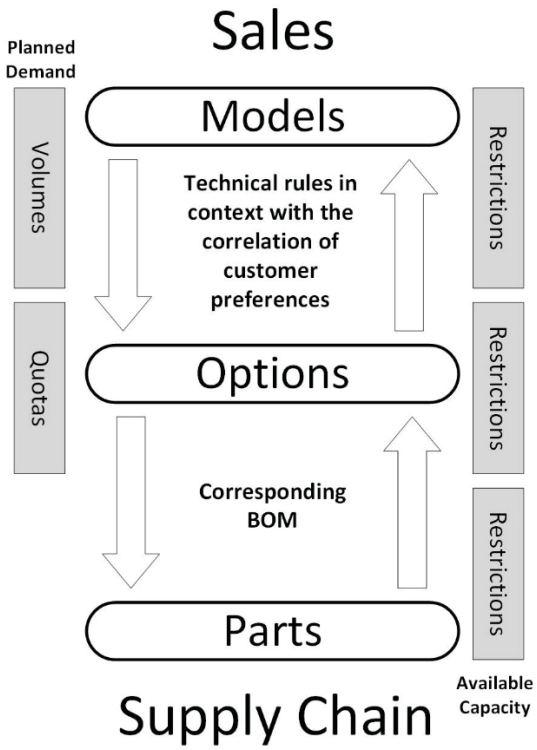

Figure 1: Bridging the gap between demand information and capacity information

Moreover, a highly fragmented information landscape is typically holding the data. The complexity of the DCM processes could be reduced immensely by an integrated information base. Highly innovative systems integrate all related data from sales to supply chain into a consistent and integrated information structure, so providing the crucial basis for a continuous DCM process.
A number of publications, which have introduced innovative processes and methods for DCM (e.g. approaches of Wagner 2006, Ohl 2000, Wagenitz 2007, and Stäblein 2008) has been evaluated by Wagenitz et al. 2011. Thereupon, Wagenitz et al. 2011 have developed an approach that applies planned orders for calculation of part demand for the automotive industry.
At several German OEMs, these algorithms have been implemented and validated. The respective tool suite is known under the name of OTD-DCM, where OTD refers to the core software module OTD-NET (order-to-delivery and network simulator, cf. Wagenitz 2007). To reduce the amount of data of BOM rules and to optimize their terms, optimization methods are used in this approach. The next chapter presents the underlying concepts. The analysis of the complexity reduction gained by these optimization methods is given in chapter 3. Chapter 4 gives a conclusion including a summary and a perspective on future research and development.

2. Hierarchical product structure and optimization methods used in the DCM

DCM planning variables, i.e. model volumes and option quotas, typically include several million variables. These planning variables are related to part demands and capacity restrictions by technical rules and BOM rules. For example, a capacity restriction may exist which limits the number of a specific powerful battery. Therefore, the selection of this battery may depend on several combinations of options, e.g. the battery is only selected if specific electronical options are chosen. All BOM rules and technical rules that relate directly or indirectly to that battery have to be analyzed to derive restrictions on model volumes and option quotas. In the worst case this sums up to a significant fraction of the overall number of rules. These could amount up to 15,000 technical and 600,000 BOM rules for a midrange model. Hence, it is important to assure consistency and avoid redundancy in and between all data entities when integrating data into one data structure. Inconsistencies occur for example when subsets of technical rules contradict each other so that orders cannot be specified fully. Therefore, it is necessary to check planning relevant information against structural requirements and to verify consistency. This data processing step has been implemented in OTD-DCM based on the principle of a hierarchy-linked structure of variant clusters (cf. Meininger 1994, p. 32ff). Thereby, a variant cluster is defined as a subset of allowed vehicle variants, that have common properties (for example: sales region=Germany, body=medium class sedan, engine=150hp diesel, transmission=automatic, and trim=comfort). The pre-optimization of the product structure is the generation of the hierarchical data tree. These tree levels are based on detailed variant cluster specifications and may be defined for example by the model type, target country, engine type etc. Each level can have one to several nodes, depending on the level and type of car (e.g. gasoline, diesel, electronic for the fuel nodes). As all product information have a specific temporal validity, these dynamics have to be handled within this tree structure (Wagenitz et al. 2011, p. 19).

This paper especially focuses on the processing and thus complexity reduction of rules when generating this hierarchical structure. In the following the tree steps of this optimization will be described.

1. The first method identifies all forced options. A forced option is an option that has necessarily to be chosen for a specific variant cluster (e.g. every car for the German market requires a specific exhaust system). Therefore, principally allowed options for one variant cluster are reduced by non-feasible options. This evaluation is done by checking intelligently selected, partly specified theoretical configurations against all applicable technical rules. If a contradiction occurs, the option will be deleted from the set of allowed options. When this process leads to only one possible option from a set of alternative options, this option is set as forced.
   Furthermore an inner inconsistency is identified if the last identified forced property violates a technical rule. There are two kinds of outer inconsistencies that can be identified. First, if a positive demand quota for an option has been planned, but the option itself is technically not allowed. Another one is identified, if the sum of all planned quotas for all allowed options within a subset of alternative options in a specified time period does not equal 100%.

2. The second optimization step reduces the number and the length of rules. Compared to the first method it should be noted that these steps are valid only for one variant cluster and a specified time period. Therefore these steps need to be executed for each variant cluster and all relevant time periods. The OTD-DCM implementation is able to shorten rules by merging several BOM or technical rules that belong to more than one resource, i.e. workstations, assembly lines and more (Wagenitz et al. 2011, p. 19; Liebler 2013, p. 101, 110).
   Next, this second optimization step aims to reduce the actual length of all rules by Boolean simplification of terms and by application of the Identity Law of the Boolean algebra (cf. Goodstein 2007). If the optimized length of the rule is shorter than the original one, it is replaced by the new representation. As an example the Boolean expression "$\neg (\neg A \wedge B \wedge \neg C)$" will be reduced to "$\neg B \vee A \vee C$".

3. The third and last optimization step tries to identify commonalities for nodes in the hierarchical product structure. This means that rules that are valid for each child node of one variant cluster are moved upwards to the parent node and deleted from all children. The preliminary condition for this step is that all derived variant clusters share this rule over the same time period.
   Example: The forced option “Owner’s manual in German language” is valid for all variant clusters within the sales market = Germany. As result, it will be transferred upwards to the variant cluster "variants - German" and deleted from all derived variant clusters (Wagenitz et al. 2011, p. 19).

The next chapter presents an analysis of the complexity reduction, which is performed by the previous described optimization methods.

3. Analysis of complexity reduction

The evaluation of the previous described optimization methods has been executed on real data for two car series from a German OEM. It should be noted that these two car series represent only a small fraction of the OEM portfolio and the analysis is limited here on BOM rules only. The results of the evaluation with and without the presented optimization methods can be seen in Table 1. In the following the parameter *n(l)* is defined as the number of tree nodes on a level. A tree node represents a variant cluster as described in the previous chapter. The respective sum of BOM rules before optimization are defined as $r^{pre}(l)$ and after optimization as $r^{post}(l)$. The number of average rules per tree node within a level is defined as $a^{pre}(l) = r^{pre}(l)/n(l)$ and $a^{post}(l) = r^{post}(l)/n(l)$. A null-entry rule characterizes a rule without condition, consequently the rule is valid for the whole variant cluster. These null-entry rules are accordingly defined as $v^{pre}(l)$ and $v^{post}(l)$.
The results in Table 1 show that the lowest level of the hierarchical product structure contains all existing BOM rules $r^{pre}(l)$ before all optimization. After optimization, the number of several BOM rules has been reduced and hoisted to higher levels resulting in $r^{post}(l)$.

Table 1: Indicators without optimization (pre) and with optimization (post)

level *l*	*n(l)*	$r^{pre}(l)$	$r^{post}(l)$	$a^{pre}(l)$	$a^{post}(l)$	$v^{pre}(l)$	$v^{post}(l)$
1	1	0	38	0	38	0	35
2	2	0	4,389	0	2,194	0	2,554
3	3	0	1,204	0	401	0	425
4	3	0	0	0	0	0	0
5	4	0	1,293	0	323	0	498
6	4	0	0	0	0	0	0
7	5	0	1,047	0	209	0	111
8	8	0	4,101	0	512	0	845
9	8	0	0	0	0	0	0
10	8	0	0	0	0	0	0
11	12	0	1,501	0	125	0	416
12	184	1,076,428	97,497	5,850	529	287,841	7,324
	sum	**sum**	**sum**	**weighted average**	**weighted average**	**sum**	**sum**
	242	1,076,428	111,070	4,448	458	287,841	12,208

Furthermore, the overall number of rules is reduced from 1,076,428 to 111,070, which amounts to a reduction of 89.7% in relation to the original number.
The reduction as well as the average ratio of rules per node are recognizable by comparing $a^{pre}(l)$ and $a^{post}(l)$. The weighted average considers the number of nodes per level, where the reduction in this case also results in 89.7% coincidentally. As a result, this analysis proves the immense complexity reduction by application of the OTD-DCM hierarchical product structure.

4. Results and conclusion

DCM represents an integral component of the automotive supply chain management. Resource requirements, resulting from future or already realized market demands, are synchronized with capacities and restrictions of the supply chain and production system. Nevertheless, it is impossible to predict the exact future vehicle orders, because customers can choose from billions of possible configurations for each car type. The compatibility of options for a respective car model is described by a complex set of technical rules, while the relationship between the fully-configured car type and the corresponding parts is described by the BOM. The integration of distributed product data into a hierarchical tree structure has been analyzed against the background of complexity reduction in this paper.
It has been demonstrated that the total number of BOM rules could be reduced by 89.7% (nearly a factor of 10). In result, the hierarchical integrated information model seems to prove as an optimized basis for a scenario-based planning process in DCM for the automotive industry. Here, transparent and consistent data is required. Furthermore, the reduction of the complexity in this model may save computation time and memory space while performing scenario simulation (Wagenitz et al. 2011, p. 30).
Nevertheless, as only a small information model (two car series of the OEM portfolio) has been considered here, an analysis of a full product spectrum as well as the propagated rules may be necessary to provide greater insights into the effects of the optimization steps. In addition, future work shall also analyze if a generic graph structure instead of the applied tree structure holds further benefits in terms of complexity reduction.

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Supporting pen-and-paper role-play using Android and augmented gaming materials

Manuel Fried, Sebastian N. Kaupe, Christian Reimann, Konstantin Koll

mail@manuelfried.de, sebastian.kaupe@stud.fh-dortmund.de, christian.reimann@fh-dortmund.de, konstantin.koll@fh-dortmund.de
University of Applied Sciences and Arts Dortmund
Emil-Figge-Straße 42, 44227 Dortmund, Germany

Keywords: Android, role-playing, role-play, pen-and-paper, augmented die, Bluetooth die, QR code

Abstract: During pen-&-paper role-playing sessions, several players meet to steer fictitious characters through a story cooperatively told by a game master and the players themselves. During those stories, combat may ensue, which heavily burdens the game master with organisational tasks.
Using the (in Germany) popular [1] game system "The Dark Eye" as a basis, we implemented an Android application to support the game master by performing his organisational tasks during combat situations, offering simple-to-use functionalities to lessen his burden without restricting the freedom traditionally enjoyed by the game master. To facilitate the adoption, usage of haptic elements augmented with QR codes and wireless devices was evaluated and prototypes of promising approaches implemented.

1. Introduction

Role-playing games, often called pen-and-paper role-playing games due to the required use of those utensils, are a type of cooperative game played by a group of players. A *game system* provides a basis to play upon, such as rules and required utensils, but often also a description of the game's setting.

"Fantasy role-playing games may in very simple terms be described as a mixture of board game, story-telling and improvisational theatre. The idea of the game is giving the players the ability to play the role of an imaginary character in a fictitious, interactive adventure story. The outcome of it is uncertain and they can take part in shaping it." [2, own translation]

Not all players are equal, though. One member of the group fulfils the role of the *game master*, whose job is to prepare the story for play (either by buying a commercially available adventure or creating one themselves) and present it to the other players not only by describing locations, persons and events, but also by playing every character not controlled by the players (so-called *non-player characters*, *NPCs*). In essence, the game master is the other player's window into the game's world.

In exchange, the game master may bend, break or straight-out ignore any rules if he thinks it dramaturgically appropriate, or create new rules should they be needed (e.g. when a player wants to do something not already covered by the existing rule set). Due to the open-ended nature of role-playing games, in which the players are free to basically ignore the prepared plot in favour of an unplanned camping trip, a lengthy in-game discussion about metaphysical or social aspects of the game's setting or simply an evening in the local tavern, these rights may be frequently made use of.

Naturally, the position of the game master is a demanding one, requiring the allocation of free time for preparation, a solid understanding of the game's rules, a talent for improvisation and a

certain amount of imagination. This holds especially true in the case of combat situations, which may frequently appear over the course of an adventure as one type of obstacle the players have to overcome in order to advance the plot.

Unlike non-combat situations, in which players may interact freely with each other and the fictional environment in what usually amounts to real-time, combat is a heavily regulated, usually turn-based affair, with the game master being responsible for many things: Determining the order of combatants, placement of obstacles and combatants, tracking the state of all NPCs involved and the memorization of events and time constraints. All of these tasks require constant attention and the frequent taking of notes.

With the game master in control of all NPCs and most fights being between the players on one side and a group of NPCs on the other, he also has to come up with a strategy that should make the combat interesting and challenging to the players without being unfair, adding another burden.

2. Related work

While no research concerning the electronic support of role-playing games was found, a number of studies have discussed the augmentation of traditional board games [3].

There are a number of freely and commercially available applications that allow role-playing gamers to play a number of different game systems over the internet. However, they are not meant to be used as a tool during in-person role-playing meetings, and none support augmented gaming materials.

3. Proposed solution

In order to lessen the burden resting on the game master, we proposed the development of a mobile application for tablet computers, capable of performing the most important organisational tasks of the game master for him. Wherever possible, automatization should be applied, but with an option for the game master to exclude parts of the automated processes.

Android was proposed as a platform for the application due to its high distribution, having been the operating system of over 80% of all smartphones sold in 2015 [4]. Furthermore, cheap Android-based tablet computers are easily available, reducing the financial requirements—an important factor, given the already existing financial burden of obtaining the necessary rule books and required gaming materials (such as dice).

In order to increase the acceptance of the application, we furthermore proposed the inclusion of augmented gaming materials already familiar to the players, such as dice or reference cards. Augmentation should be performed in non-obstructive ways, allowing for the continued traditional use of the materials.

The ultimate goal of the application is to enable the game master to spend less time with menial tasks, giving him more time to focus on tasks creating immersion and, by extension, a more satisfying gaming experience for all players.

4. Key aspects of the implemented solution

The Android application proposed was implemented using a Rapid Application Development scheme, using iterations of one week due to the time constraints imposed by the development

being part of the author's bachelor thesis. Due to its popularity in Germany [1] and the author's familiarity with it, the game system "The Dark Eye" was used as a basis.

The application, given the name ALRIK after a common name in the setting of "The Dark Eye," supports the game master with a number of features: The game master may create templates for combatants, which are stored in the database for future use, and add them quickly to a fight. The order and state of combatants is determined and updated automatically. ALRIK is capable of simulating dice rolls for the most important actions undertaken in a fight (such as attacks or parries). The game master may create effects to change a combatant's state, receiving notifications when effects expire, freeing him from having to remember all currently active effects for all non-player combatants. Timers may be created to remind him of important events happening after a certain number of rounds, such as the arrival of reinforcements or the beginning of a storm. A map made out of hex tiles allows for a higher degree of battle overview, supporting the placement and selection of combatants. Colours are customisable to support not only personal preferences, but also game masters with colour deficiencies.

Another way to add combatants to a fight is the usage of augmented reference cards. A reference card is a small paper card, containing all the information necessary for a combatant. We augmented those cards by encoding said information in QR codes attached to the cards. In order to add one or more instances of the combatant pictured on the reference card, the game master selects the appropriate option in the application and scans the QR code using a scanning application.

We considered the use of RFID tags for the same purpose, but decided against those due to their higher price in comparison to the paper and ink required by QR codes and a lack of RFID receivers in many tablet computers. For the same reason, the idea to use NFC hardware buttons that the game master could stick on their tablet device or any nearby surface to execute a configurable action on a press of the button was discarded.

Dice are elementary to most role-playing systems. Used to determine the success of actions undertaken by the player characters, rolling one or more dice is one of role-playing most important rituals, involving many of the player's senses [5]. For this very reason, players are usually sceptical of replacing physical dice with random number generators. Some of the tools available for online play (c.f. [6]) try to lessen this effect by simulating dice throws using animated 3D dice visualisations or even physically-simulated dice the user can roll using a mouse or similar input device.

Figure 1: Augmented die

In contrast, we implemented a die capable of transmitting the result of a die roll to our application using an embedded Bluetooth sender supporting the low-energy consumption mode of newer Bluetooth version. The hull of the die was assembled using triangles cut from acrylic glass, forming a twenty-sided die used for most rolls in "The Dark Eye." A commercially-available sensor board for wearables [7] containing an accelerometer was placed inside the hull and the empty space filled in with hot glue. To allow for easy access of the board, e.g. for recharging, the die incorporates a lid held in place by neodymium magnets embedded in the hot glue.

Using this augmented die, the game master may replace the automatic dice rolls performed by ALRIK by rolling the Bluetooth die, restoring the sensual impressions he is used to without having to input the results of a die roll into the application manually.

5. Results and Conclusion

Testing of our latest development iteration showed promising results. ALRIK was accepted by the game masters, even though it is still considered to be in a prototype state, containing placeholder graphics and lacking advanced capabilities, such as dedicated support for magic spells, automatic application of optional rules and placement of objects on the map.

The augmented elements were initially approached with scepticism, but considered as noteworthy once tested. Game masters still refrained from using them, though, due to their prototype status. Especially the imbalance of the Bluetooth die, caused by the embedded board and magnets was cause for criticism and needs to be addressed to ensure the die's acceptance.

Tests of the reference cards augmented with QR codes highlighted a possible problem: Space on the cards is limited, constraining the maximum amount of information transferrable. An obvious solution would be to outhouse the actual information onto a web server and only encode an appropriate link in the QR code, but this would require an explicit license to do so from the game's copyright holders.

Player feedback was positive, with players reporting a feeling of a faster, smoother gaming experience settling in after a short settling-in period of roughly five rounds.

We consider the approach of carefully supporting role-playing using augmented gaming materials in combination with a mobile application on a compact device as viable. While the augmented elements are still in a prototype state and have to undergo further development, their use has the potential to increase player satisfaction by freeing the game master from menial tasks in favour of tasks creating immersion and interesting gameplay.

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Acoustic-Coupled Communications Systems With Modern Web-Browser APIs

Ulf Müller-Baumgart, Tim Zebulla, Prof. Dr. Christian Reimann
Fachhochschule Dortmund University of Applied Sciences and Arts

Abstract

This paper proposes a system which uses modern web browsers as a uniform runtime environment for acoustic-coupled communication systems using modern web browser APIs. After a brief introduction to acoustic coupling and the WebAudio API, the authors propose a system which provides AirChat [13] like functionality while relying on state of the art JavaScript APIs and HTML5.

Introduction

Communication plays a vital role in various aspects of life. Especially in disaster areas, as well as in remote areas like the australian Outback or deserts the ability to communicate may be a necessity to survive. The community life and many aspects of the private life depend on communication affordable to the public.

Communication provides means to enable medical supply, e.g. in humanitarian operations, economy, and social life. In this context, data encryption and data authenticity are basic requirements to ensure privacy and reliability which are key when transmitting sensitive data e.g. medical records or doing payment transactions.
Various solutions exist, popular ones being FireChat [15], AirChat [13] and Serval [7].

To use WiFi as a usable and affordable solution may appear sensible. The short range of usual WiFi devices drives this technical approach useless to connect wide areas. Especially disasters hit usually wide areas. To cover wide areas like this UHF radios are used for voice over radios.
To close infrastructure gaps the store & forward principle is a promising solution. Every data is stored when received and forwarded when possible as a bulk data bundle.
On the countryside it's quite common to have radio sets in the cars. The charity organisations like the Red Cross carry radio sets in their equipment.
This radio devices guaranty a good reception for voice communication but are limited to voice transmission. To transmit data like images, maps, weather forecasts, public alerts or warnings a way to transmit digital data is needed.
To enable the radios to transmit digital data acoustic modulation is used like known from the old dial-up modems with low costs. Many voice acoustic transmission medias can be used like telephone lines, voice radios, broadcast radio. While many modern devices like smartphones, notebooks or tablets have audio capabilities a wide range of devices can be used like mentioned in [1].

While existing solutions such as AirChat (using Fldigi [12]) or PSKMail [14] depend on certain operating system features e.g. a Perl runtime environment, this paper proposes a system which uses modern web browsers as a uniform runtime environment for different devices. By relying only on state of the art JavaScript APIs and HTML5, the proposed system aims to be platform independent, easy to deploy, easy to distribute and small in footprint.

Introduction to Acoustic Coupling

Acoustic coupling has been introduced in “Acoustic Coupled Disaster & Remote Communications Systems” [1]:

“The modulation is done by using common modulation schemes. Usually a radio transmission is done by modulating the carrier with eg. frequency shift keying (FSK). This modulation scheme known from the older day of telephone modems uses two frequencies to represent the different states of the digital stream. Usually the carrier frequency would be eg. higher representing a 1 and a bit lower for a 0.” [1]

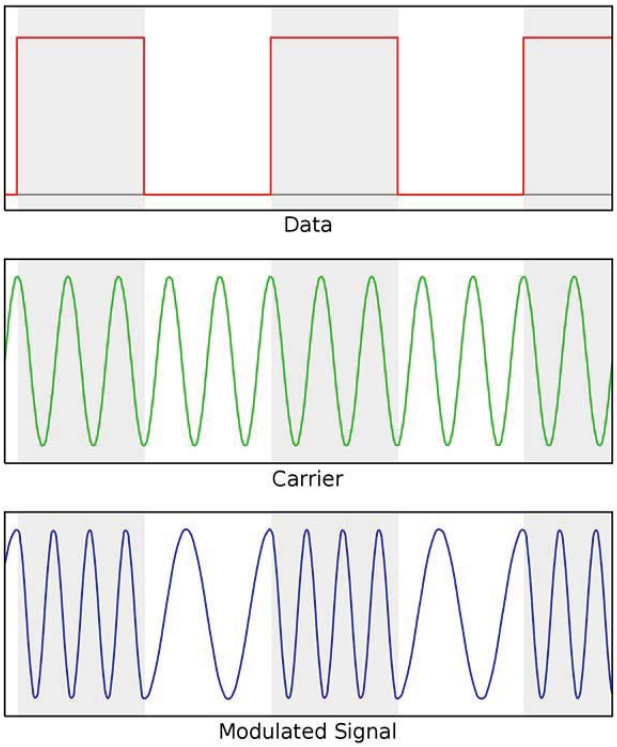

Figure 1: *Frequency Shift Keying Modulation. Logical high is represented as higher frequency whereas logical low is represented as lower frequency. Image credit: Keenan Tims, CC-BY-SA.*

Introduction to WebAudio API

While acoustic modulation with modems is quite old in computer science, audio processing in browsers was only possible by using proprietary plugins like Adobe Flash. The W3C WebAudio API Draft tries to close this gap:

“Audio on the web has been fairly primitive up to this point and until very recently has had to be delivered through plugins such as Flash and QuickTime. [...] For sophisticated web-based games or interactive applications, another solution is required. [...] The APIs have been designed with a wide variety of use cases in mind. Ideally, it should be able to support any use case which could reasonably be implemented with an optimized C++ engine controlled via JavaScript and run in a browser. [...] The API has been designed so that more advanced capabilities can be added at a later time.“ [2]

The Web Audio API provides synthesizer and analyzer components like filters, frequency generators, and a fast Fourier transform (FFT) implementation. At the moment the FFT component is limited to the magnitude spectrum and lacks the capability to access the phase spectrum.

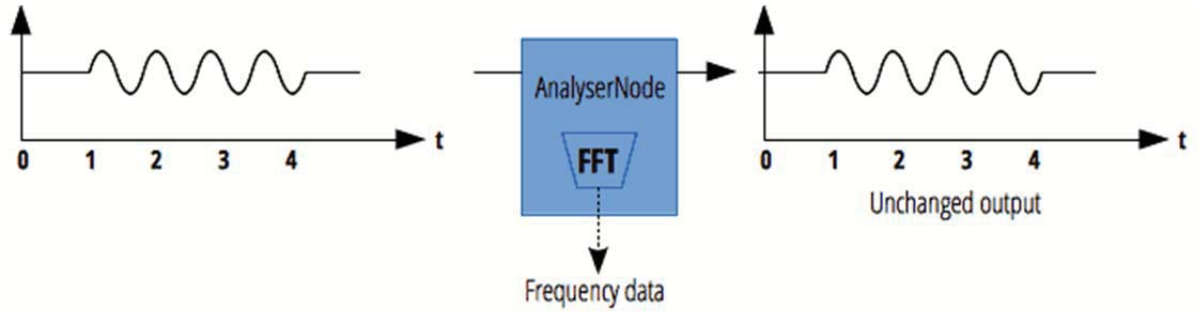

Figure 2: *The analyser node of Web Audio API transforms the audio data of the time domain to the frequency domain. The magnitude spectrum is accessible while the phase spectrum is not accessible at this state of the draft. [3]*

Furthermore there is no component which provides an inverse fast Fourier transform (IFFT) implementation. The IFFT is a basic requirement for more complex modulation schemes. At the current state using the WebAudio API limits implementable modulation schemes to amplitude and frequency modulation. However implementing frequency modulation is straightforward [4]:

```
// create audio context
var ctx = new webkitAudioContext();
// two oscillators and one gain
var mod = ctx.createOscillator(),
   modIndex = ctx.createGain(),
   car = ctx.createOscillator();
// setting parameters
mod.frequency.value = 100;
modIndex.gain.value = 40;
car.frequency.value = 440;
// connect all
mod.connect(modIndex);
modIndex.connect(car);
car.connect(destination);
```

Figure 3: *Frequency modulation using WebAudio API [4]*

Proposal for Acoustic-Coupled Communications Systems with modern Web APIs

To achieve AirChat like functionality using web APIs, i.e. a straightforward user interface providing text input and file upload fronting a acoustic coupled transmitter, the following parts would have to be implemented.

The user interface would be developed using HTML5 and CSS3 to adapt to different devices.

The business logic would consist of three modules. The program logic in conjunction with the Web Cryptography API [5] as one module, a data modulation and acoustic output module using WebAudio API, and a networking module realized with WebRTC [6].
All data transmitted and received can be cryptographically signed, verified, encrypted or decrypted using the Web Cryptography API to assure security through the store & forward network.
Using the Web Audio API the data modulation and demodulation and acoustic output is realized.
By using WebRTC a peer to peer network layer can be established similar to networks known by the Serval Project [7]. Bridging functionality between the acoustic coupled network and a local WiFi network similar to the one mentioned in “Acoustic Coupled Disaster & Remote Communications Systems” [1]

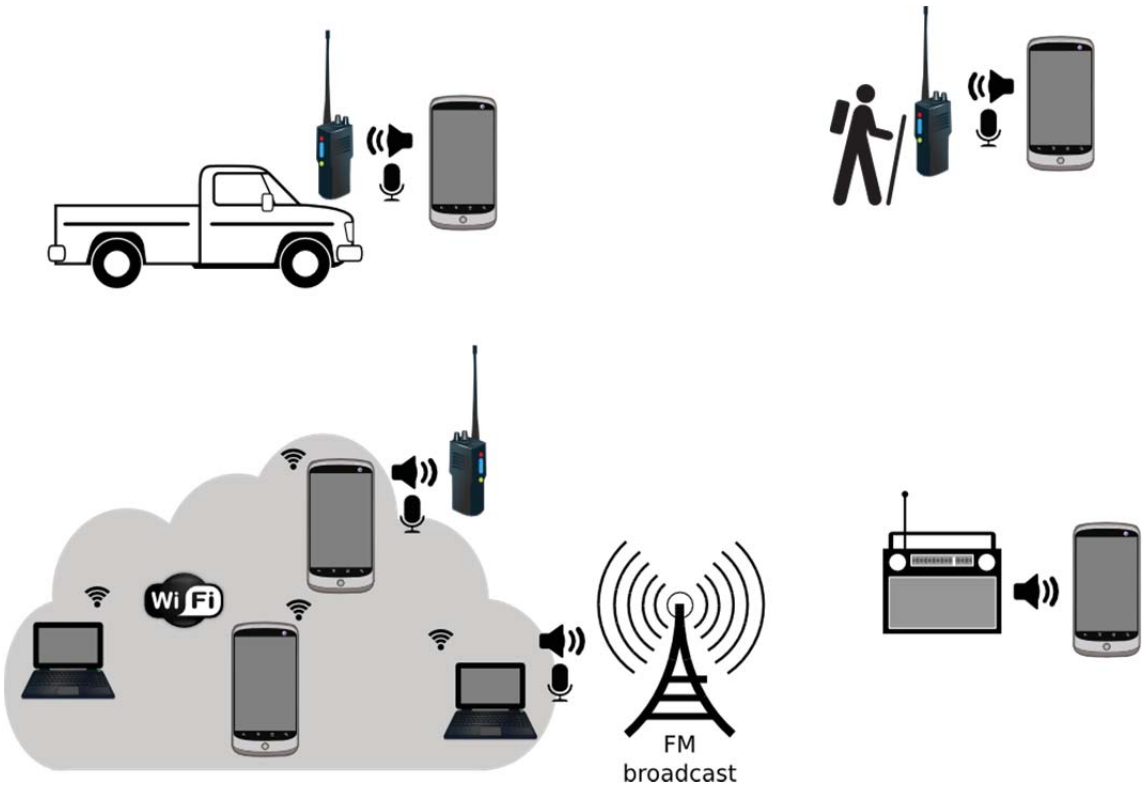

Figure 4: *A acoustic coupled network can be used to reuse existing voice radio and radio broadcast infrastructure to transmit digital data. In conjunction with network technologies like WiFi this technique can be used to bridge regular networks. [1]*

By using the File API [8], data from the local filesystem can be accessed e.g. to load data which shall be transmitted or store received data.
Furthermore the File API can be used to store configuration data and cryptographic keys. In this way the application is configurable and customizable with a persistent storage. If the user closes the application and opens it again it will appear the way the user expects a native application to behave.
In conjunction with the Web Cryptography API the local storage can be encrypted.

Anticipated properties, limitations and challenges

Most of the APIs mentioned in this proposal are still in draft status. Hence future changes are to be expected. This may introduce significant changes and therefore break the current implementations. Adoption of the features varies in different web browsers.
Additionally, some APIs currently lack important features e.g. IFFT not being a part of the Web Audio API specification.

Existing third party libraries and frameworks using the Web Audio API are prominently targeting musical appliances such as audio effects or audio visualization. The web audio API is rarely used for pure signal processing. Thus most functionality would have to be implemented from scratch using basic Web Audio API techniques.
Furthermore implementing a performant modulation scheme without the support of a native IFFT implementation may be most likely impossible or at least quite challenging.
The lack of accessibility of the phase spectrum significantly limits demodulation capabilities.

Conclusion

In summary, the proposed concept looks promising in aspect of flexibility and portability.
Platform independence and rapid deployment support are desirable goals in providing and enhancing disaster area communication systems. Using open source technology and open standards provides sustainability. Despite the unfinished status of the APIs, the draft specifications show promise. The Web Audio API already includes most of the necessary signal processing functionality, the Web Cryptography API draft proposes basic cryptographic functionality. The WebRTC and File API specifications already contain all functionality necessary to implement the use cases mentioned in this paper.

Future Work

To enhance the Web Audio API accessibility to the phase spectrum could be implemented to give a wider range of capabilities to work with more complex audio analysing techniques. This will lead to a new variety of new filter types.
To implement more complex audio features like digital acoustic modulation schemes a IFFT implementation is necessary. Even for regular audio filters, effects or encoders IFFT may lead to new implementations.
By implementing modular AudioNodes [9] a straightforward use of modulation schemes will be possible. The application would be extendable with new modules. For a selection of modulation schemes modules would be implemented.

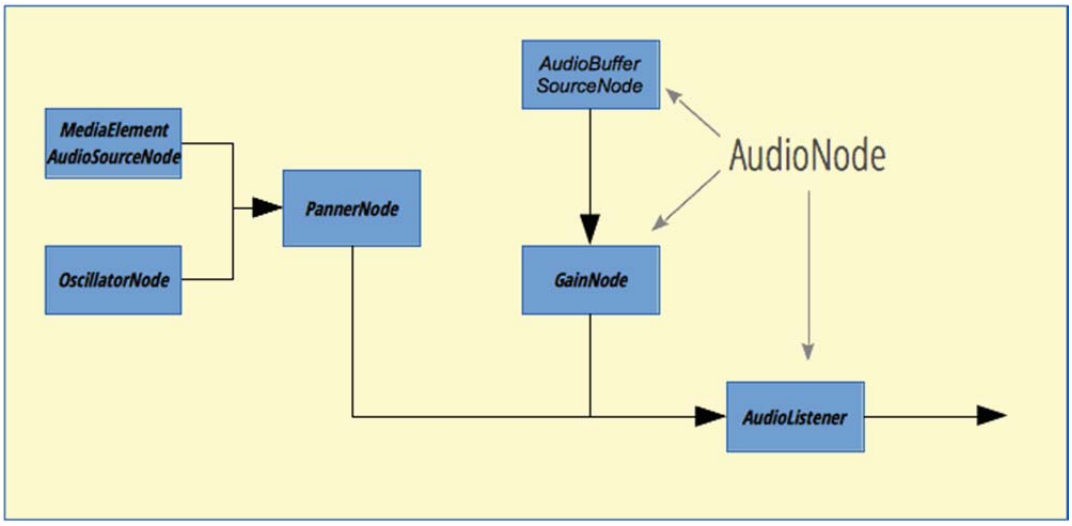

Figure 5: *AudioNode routing [9]*

A approach to overcome the limitation of javascript to be stopped after a while or if the browser application is closed asynchronous processing techniques such as the Web Workers API [10] could help.

This API could start background tasks which could run as processes and handle modulation or demodulation tasks or networking tasks.

"Web Workers provide a simple means for web content to run scripts in background threads." [11]

With the introduced proposal and the APIs a port of existing disaster area communication applications like Serval Project [7] could be ported to the browser and would be even more portable than the current application.

Acknowledgements

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Open Edge Computing – From Vision to Reality

Rolf Schuster

Rolf.Schuster@OpenEdgeComputing.org
Open Edge Computing Initiative
www.openedgecomputing.org

Keywords: edge computing, wearable computing, assisted driving, drone control, mobile computing, cloud computing, cloudlet, cloud offload, virtual machine, Google Glass

Abstract: In *edge computing*, a small data center called a *cloudlet* is placed at the edge of the Internet, in close proximity to mobile devices or sensors. In this paper we show how a disruptive force in mobile computing can be created by extending today's unmodified cloud to a second level consisting of cloudlets, located just one wireless hop away from associated mobile devices or sensors. By leveraging low-latency offload, cloudlets enable a new category of near real-time applications which will be utilized in many different industries. By processing high data rate sensor inputs such as video close to the point of capture, cloudlets can reduce ingress bandwidth demand into the cloud. By serving as proxies for distant cloud services that are unavailable due to failures or cyberattacks, cloudlets can improve robustness and availability. We caution that proprietary software eco-sytems surrounding cloudlets will lead to a fragmented marketplace that fails to realize the full business potential of mobile-cloud convergence. Instead, we urge that the software ecosystem surrounding cloudlets be based on the same principles of openness and end-to-end design that have made the Internet so successful.

1. Introduction

The Internet economy of the G-20 countries is estimated at roughly $4 trillion today [2]. How does an ecosystem that is built on top of a handful of simple protocols (such as IP, TCP, DNS, DHCP, HTTP and TLS) manage to deliver such high value? Key to this success is the openness of the Internet, based on an end-to-end design philosophy for applications and services. Any Internet application works the same way anywhere in the world, and can be used over any low-level networking technology. The network may affect performance and usability, but not functional compatibility. This emphasis on end-to-end design ensures universal interoperability, and leads to an expanding (rather than fragmented) marketplace for applications and services as the Internet grows. Most importantly, applications do not have to be modified to benefit from networking improvements.

This paper puts forth the view that it is crucial to preserve this end-to-end design philosophy even as the tectonic forces of mobile computing and cloud computing converge upon each other. Their convergence in the area of edge computing exposes many short-term business opportunities that are tempting, but would lead to violations of the Internet's end-to-end design philosophy. Instead, we advocate an open ecosystem based on the concept of cloudlets that run open-source derivatives of the OpenStack cloud computing software. We show how such an ecosystem can support many exciting new classes of mobile applications that leverage both centralized and distributed cloud resources and services.

2. The Limits of Cloud Consolidation

Why is the cloud relevant to mobile computing? One reason is access to cloud services such as Google Maps, YouTube, Netflix, Facebook and Twitter. A second reason, unique to mobile

devices, is for offloading operations to improve performance and to extend battery life. The rich sensing capabilities of a mobile device (such as accelerometer, microphone, and camera) can then be combined with compute-intensive or data-intensive cloud processing. The Apple Siri voice recognition system, the Google Goggles augmented reality system, and the Amazon Silk browser are examples of systems that use this approach. The most sought-after features of a mobile device are light weight, small size, and long battery life. Hence, it´s computational power will always lag behind the computational power of servers [5]. By using the cloud, a mobile device can overcome its computational limitations.

The term "cloud" evokes centralization. Today, a cloud service is typically consolidated into a few large data centers. Unfortunately, global cloud center consolidation implies large average separation between a mobile device and its cloud. End-to-end communication then involves many network hops and results in high latencies. However, low end-to-end latency is crucial for near real-time applications, so called "tactile applications". Can the benefits of cloud computing be preserved without excessive end-to-end latency?

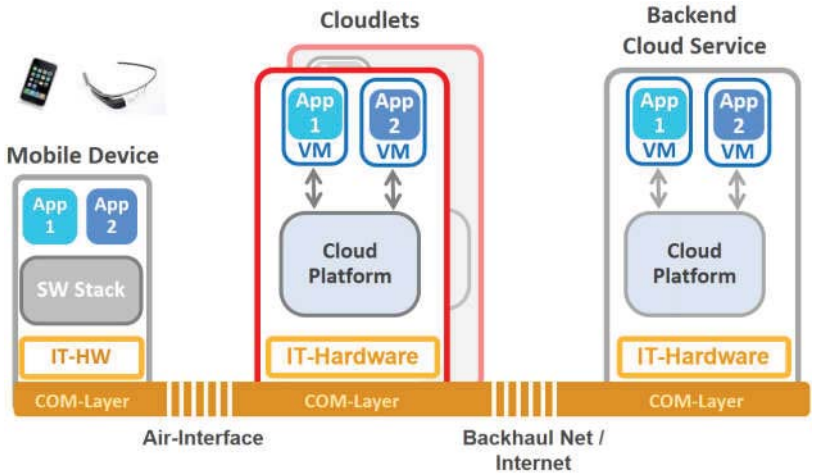

Figure 1: Two-Level Cloud-Cloudlet Architecture

Figure 1 shows how this can be accomplished using a two-level architecture. The first level is today's unmodified backend cloud service. The second level consists of dispersed elements with no hard state called cloudlets [7]. A cloudlet is effectively a "second-class data center" with soft-state generated locally or cached from the first level. The central message of this paper is that cloudlets should be viewed as Internet infrastructure, subject to the same principles of openness, transparency and end-to-end design mentioned in Section 1. This viewpoint is consistent with Cisco's concept of fog computing [1].

In the two-level model of Figure 1, data center proximity to mobile devices is achieved by cloudlets without limiting the consolidation achievable in the cloud. Communication between the cloud and a cloudlet is outside the critical path of interactive mobile applications. In addition to the latency benefit, cloudlets also provide a bandwidth benefit. The one-hop wireless bandwidth between a mobile device and cloudlet can be much higher than the end-to-end bandwidth into the cloud. This can help bandwidth-intensive applications such as real-time computer vision analytics for a large number of video cameras monitoring a city.

The importance of cloudlets can be seen in the results shown in Figure 2 for face recognition on a mobile device. Full details of these experiments be found in the paper by Ha et al [4]. An image from the mobile device (located in Pittsburgh, PA) is transmitted over a Wi-Fi first hop to a cloudlet or to an Amazon data center. The image is processed at the destination by computer

vision code executing within a virtual machine (VM). For face recognition, the identity of the person is returned. Each curve in Figure 2 corresponds to the CDF of the observed response time distribution. The ideal curve is a step function that jumps to 1.0 at the origin. Figure 2 shows that this ideal is best approximated by a cloudlet. End-to-end latency plays a dominant role, as shown by the worsening response time curves corresponding to more distant AWS locations. The label "mobile-only" in Figure 2 corresponds to a case where no offloading is performed, and the computer vison code is run on the mobile device. The data shows that mobile-only does worse than using the cloudlet. Offloading the computation from the mobile device to the nearby cloudlet is clearly important for the latency sensitive face recognition application.

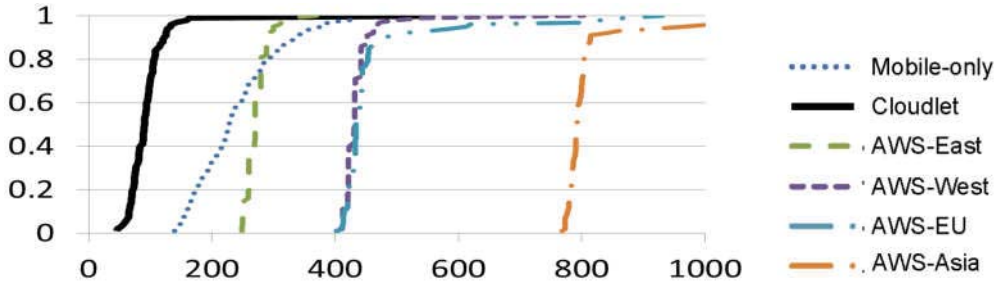

Figure 2: Response Time Distribution for Face Recognition Application (Source: Ha et al [4])

3. Edge Computing Application Areas

The proximity of the cloudlet to the mobile device or sensor enables a large variety of applications. We can distinguish the following application categories: Tactile Applications, Edge Storage & Analytics Applications, Telecommunications Support Services, Local Privacy Enforcement and Cloud Resilience.

Tactile Applications
The physical proximity of the mobile device or sensor to the cloudlet enables services with low end-to-end latency, high bandwidth, and low jitter. This is crucial for tactile applications like wearable cognitive assistance (see Section 4), virtual / mixed reality applications, assisted driving, robot / drone motion control services and virtualised customer premise equipment (vCPE).

Edge Storage & Analytics Applications
The uptake of Internet of Things (IoT) and Big Data Analytics drives further use-cases of edge computing. Here the high-volume sensor data is stored and pre-analyzed at the edge and only a small number of relevant data-sets are forwarded to the central cloud system. Typical examples for those use-cases are edge video analytics and storage of frequently updated, high resolution 3D street models.

Telecommunications Support Services
Edge computing offers quite a few opportunities for telecom network operators regarding internal service improvements. Typical services in that area are adaptive traffic shaping, edge content caching and video streaming optimization.

Local Privacy Enforcement
By serving as the first point of contact in the infrastructure for IoT sensor data, a cloudlet can enforce the privacy policies of its owner prior to release of the data to the cloud.

Cloud Resilience
With the further consolidation of cloud services many mission critical services rely more and more on just a few global data centers. Edge computing and local cloudlets could provide a fall-back infrastructure in case of a global telecom- and / or data-center service-outage.

Overall, we can conclude that there is a large number of applications which will benefit from edge computing. As these applications come from different industries, we have to ensure that we converge to one global edge infrastructure that supports all relevant industries and their specific applications.

4. Example Application: Wearable Cognitive Assistance

Using wearable devices for deep cognitive assistance was first suggested nearly a decade ago [6, 7] but is only now within reach of practical implementation. Such a system could be created by combining context-aware real-time scene interpretation (including recognition of objects, faces, activities, signage text, and sounds) with deep reasoning (using a cognitive engine such as IBM's Watson [3]). Ha et al [3] describe the architecture of a system called Gabriel (Figure 3) that uses Google Glass devices with cloudlets to provide mobile, real-time cognitive assistance. For example, such a cognitive assistance system could provide the user with the name of a person standing in front of him. Or it could suggest to water the houseplant when he looks at it.

The low end-to-end latency of cloudlets is crucial in this application because humans are acutely sensitive to delays in the critical path of interaction. Delays longer than tens of milliseconds will distract and annoy a mobile user who is already attention challenged. At the same time, cognitive engines such as those shown in Figure 3 require the memory and processing resources of a small data center. The massively parallel nature of systems like Watson are simply not compatible with running them entirely on a mobile device.

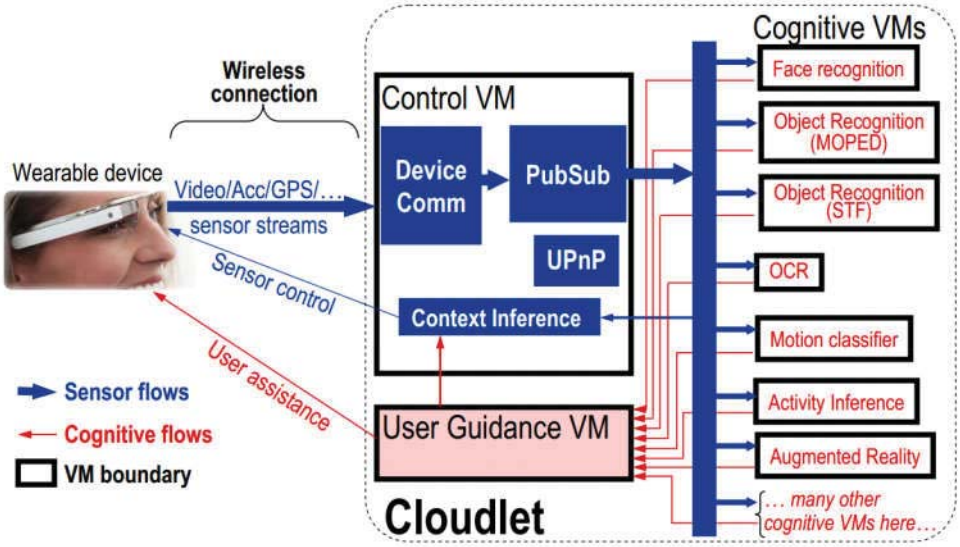

Figure 3: Gabriel Architecture for Wearable Cognitive Assistance (Source: Ha et al [3])

Human cognition involves the synthesis of outputs from real-time analytics on multiple sensor stream inputs. A human conversation, for example, involves many diverse inputs: the language content and deep semantics of the words, the tone in which they are spoken, the facial expressions and eye movements with which they are spoken, and the body language and gestures that accompany them. All of these channels of information have to be processed and combined in real time for full situational awareness. There is substantial evidence that human brains achieve this impressive feat of real-time processing by employing completely different neural circuits in parallel and then combining their outputs. Each neural circuit is effectively a processing engine that operates in isolation of others. Coarse-grain parallelism is thus at the heart of human

cognition, and this is reflected in the Gabriel architecture shown in Figure 3. Further examples for wearable cognitive applications based on cloudlets can be found at http://goo.gl/02m0nL.

5. Industry-wide Business Opportunities Drive an Open Ecosystem

We have sketched a tantalizing new world. However, without viable business models for deploying cloudlets, this vision will merely be a mirage. We face a classic bootstrapping problem. Without unique applications that can benefit, there is no incentive for deploying cloudlets. Yet, without large-enough deployments, it is an investment risk to create new applications that critically depend on cloudlets. How do we break this deadlock?

This state of affairs is similar to what existed at the dawn of the Internet (early 1980s). An open ecosystem attracted investment in infrastructure and applications, without any single entity bearing large risk or dominating the market. Over time, this leads to the emergence of a critical mass of Internet infrastructure and applications (such as email) that could uniquely benefit from that infrastructure. By the time the World Wide Web emerged as a "killer application" circa 1992, sufficient Internet infrastructure had already been deployed for growth to explode. We can follow a similar path to success with cloudlets by nurturing the creation of an open edge computing ecosystem. Emergence of a broad range of cloudlet-based mobile applications (E2E Services) require the involvement and support of a complex set of industries, communities and technology standards. Creating successful business opportunities from these services will require partnerships that jointly drive the business model innovation and agreement on core technology platforms.

As mentioned in Section 2, mainstream cloud computing today is driven by the cost efficiencies and economies of scale achievable through consolidation. Obviously, dispersed cloudlet infrastructure at the network edge will not offer these cost efficiencies. However, their unique and specific value to E2E-Services complements and enhances the highly consolidated and cost-effective cloud systems of today. Premium pricing for these services and infrastructure will therefore be possible. These benefits to all parts of the value chain are only achievable if fragmentation of the marketplace is avoided. The goal can be stated simply:

As long as authentication, authorization and billing criteria are met, any E2E service that is running on any mobile device anywhere should be able to leverage any cloudlet in the world. The decision to use a particular cloudlet at a specific point in time should be based solely on performance criteria (such as end-to-end latency, level of multi-tenancy, storage cache state, or availability of hardware accelerators) rather than network bearer or software compatibility.

The Open Edge Computing Initiative (http://openedgecomputing.org) is working towards this goal. In that context Carnegie Mellon University is creating an open source platform called OpenStack++ (http://elijah.cs.cmu.edu) that is a derivative of the widely used OpenStack platform for cloud computing (http://openstack.org). The "++" refers to the unique extensions necessary for use of OpenStack in cloudlet environments. These include: (a) cloudlet discovery; (b) just-in-time provisioning; and (c) VM handoff. OpenStack++ aims to be a universally deployable platform for edge computing, above and below which many proprietary hardware, software and service innovations can emerge.

6. Results and Conclusion

The early stages of the convergence of mobile computing and cloud computing are already under way. There is a small window of opportunity to shape this convergence so that it preserves openness and cohesiveness of software interfaces and network protocols in the new infrastructure

that will emerge. This path can lead to the kind of explosive growth seen in the Internet itself. The alternative path of multiple proprietary ecosystems will lead to a fragmented marketplace that fails to ignite exponential growth. Fortunately, there is growing awareness among industry players of the benefits of openness and end-to-end thinking in this space. We are therefore optimistic that a single open ecosystem will prevail in the converged new world. Although simple in concept, cloudlets are a disruptive force in mobile computing. Their ability to provide low latency, high bandwidth access to energy-unlimited high-end computing within one wireless hop of mobile devices is transformative. As this paper has shown, many valuable applications can be created using cloudlets. The potential marketplace for these services and their infrastructure is enormous.

7. Acknowledgement

The ideas and results presented in this paper have arisen from my discussions and research collaborations with many individuals over the last 3 years. In particular, I would like to thank Prof. Mahadev Satyanarayanan and his team at Carnegie Mellon University for their constructive cooperation and their continuous support. Furthermore, I would like to thank Mahadev Satyanarayanan, Maria Ebling, Gerhard Fettweis, Hannu Flinck, Kaustubh Joshi, Krishan Sabnani for their support and guidance with joined publication work [8].

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Systems Engineering for Metropolitan Mobility and Energy – RuhrValley

Carsten Wolff, Lena Telgmann

carsten.wolff@fh-dortmund.de
Institute for the Digitalization of Application and Living Domains (IDiAL)
Dortmund University of Applied Sciences and Arts
Otto-Hahn-Str. 23, 44227 Dortmund, Germany

Abstract: *Urbanization is turning the metropolis (or metropolitan region) into the most important organizational pattern for human ecosystems. The sustainable operation of a metropolis becomes a critical issue in size but also in complexity and heterogeneity. Smart systems help to automate and operate such ecosystems. Two major areas are mobility systems and energy systems, both in terms of complexity and sustainability. Future energy is expected to be produced from decentral renewable sources. Mobility is provided by a variety of tailored systems, including public transport and eMobility. Producers, providers and consumers have to be synchronized – sometimes while changing their roles several times per day. Metropolitan systems are too big and too complex to do that with central planning and centralized systems. Smart objects and smart systems cooperate over public infrastructure and public networks (mainly internet) in a self-organizing way. The Ruhr Valley (or Ruhr Area – Ruhrgebiet) is one a Europe's largest and most important metropolitan regions. As the former industrial heartland of Germany it has undergone a tremendous structural change. It is an example of a multi-center, diverse city cluster. Developing and changing the metropolitan mobility and energy systems for the Ruhr Valley is an excellent case study and an important topic. To develop smart systems, to connect and synchronize them over shared public infrastructure and to steer and control them close to an efficient operating point is crucial for the sustainable development of the Ruhr Valley and a challenge for the cooperative work of interdisciplinary teams of scientists, engineers, but also business experts, ecologist, politicians, and – finally – the citizens. Therefore, a joint understanding of such systems and a development process with inclusion of all relevant stakeholders is a key issue. This development process – a systems engineering methodology for metropolitan mobility and energy system – is developed by a research cluster of the three largest universities of applied sciences in the Ruhr Valley, targeting both research and education. This contribution provides a first outline of the systems engineering approach and the respective research and education agenda connected to it.*

Keywords: energy and mobility systems, smartification process, systems engineering, smart heating grid

1. Introduction

The three largest universities of applied science in the Ruhr Valley are the *Hochschule Bochum*, the *Westfälische Hochschule* and the *Fachhochschule Dortmund*. These universities have a specific role within the scientific system, in industry and in society. For the Ruhr Valley, their mission is connected to their impact on the regional development and their contribution with research results, educated people and with their "third mission" [4]. Based on this scope, the three universities are involved in several aspects into the emergence of innovative and sustainable mobility and energy solutions for the metropolitan region of the Ruhr Valley. For this purpose, they cooperate in several areas to increase their impact and to cover a broader technological scope. Chapter 5 of this contribution will describe two relevant areas of the cooperation – an industry & research cluster and a master school.

One major goal of the cooperative efforts is the development of a joint methodology with processes and tools which support and orchestrate the projects for the development of future mobility and energy systems. This methodology is intended to cover aspects of innovation management, transfer activities and project & process management. Combined with engineering methodology it forms a sub-class in systems engineering [10,11] which the partners call "systems engineering for metropolitan mobility and energy systems". This approach is based on research results on the development of "intelligent technical systems" [2] and on innovation management within the Ruhr Area (specifically for universities of applied sciences and small and midsize enterprises - SME) [14,15]. Several aspects of the approach will be described in Chapter 2. The current vision of a "systems engineering in Ruhr Valley" is outlined in Chapter 4. The joint efforts of the universities will become more relevant through the validation of the systems engineering approach within transdisciplinary research projects. Such projects involve the research institutes of the three universities, but also partners from industry and society and further scientific institutions. They are connected to the educational efforts of the universities, especially within the master's programmes. All projects will lead to concrete results (e.g. demonstrators) and solutions with a high technology-readiness-level (TRL 5-8) within the context, demand and requirements of the Ruhr Valley. Therefore, the current situation in the Ruhr Valley is described in Chapter 3 to allow an understanding of the relevant scenarios. Chapter 5 explains how the cooperation of universities, industry and society will be organized – focusing on the research cooperation and on the master school.

This paper is intended to give a holistic and comprehensive outlook on the agenda of the three universities for the next years with respect to mobility and energy solutions for the metropolitan region of the Ruhr Valley. Therefore, it combines technical concepts (within the systems engineering approach) and organizational aspects.

2. Development of Intelligent Technical Systems

Intelligent Technical Systems are the means to drive development in the era of digitalization. The term "intelligent technical systems" includes or partly covers areas like embedded systems, cyber-physical systems [12], the Internet-of-Things (IoT) [23] and to some extent data analytics and artificial intelligence [1][5]. Therefore, it touches a lot of the recent buzzwords within the trend of digitalization. The main approach is to equip technical systems which are interacting with the "real" physical world with information technology to give them additional functionality, to connect them and to gather data which allows a better optimization of their real world interaction. This approach promises gains on effectivity, efficiency and flexibility. It is one of the core arguments for the expected success of industry 4.0 – the fourth phase of the industrial revolution [3]. Our understanding of intelligent technical systems is largely influenced by the results of the German Collaborative Research Centers SFB614 - Selbstoptimierende Systeme des Maschinenbaus [2] and the German Leading-Edge-Cluster (Spitzencluster) "it's OWL" and "Effizienzcluster LogistikRuhr"[1].

For the development and application of intelligent technical systems, further aspects are relevant. Such systems require a vertical integration – from the technical "thing" to the user or the target setting system – and a horizontal integration by connecting such systems or exchanging and processing the data produced by such systems. Therefore, intelligent technical systems form technology chains (or technology networks). From a business perspective, a technology chain is the basis for a value chain and therefore highly connected to the respective business process and the relevant business models, products and service offers. From IT perspective, the vertical and horizontal information processing is forming information supply chains [20]. The integration of such chains into systems leads to Digital Business Ecosystems

[1] https://www.bmbf.de/pub/Deutschlands_Spitzencluster.pdf

(DBE). The target setting for such systems (influencing the steering and/or controlling) can be done by a target setting system – which can be the user or operator. Furthermore, humans are affected by the things that the "things" do with them – the real world interaction. Involving the people into the development process and into the operation is therefore crucial. This can include political "participation" and go up to making users to be "co-producers". From project management point of view, it is touching stakeholder management and change management. Changing and impacting the socio-economic environment needs to be addressed whenever developing or operating intelligent technical systems on a certain scale.

With such a broad and comprehensive understanding of intelligent technical systems it becomes clear that we need a common structure and understanding – a *lingua franca of systems engineering for metropolitan mobility and energy systems*. An important element of such a lingua franca is a common system model that helps to structure systems and can be used to define where to apply which methodology and which technology. I can help, too, to structure the value chains (and the respective business models), the information supply chain, aspects of energy and material flows and the relevant interaction points for users and stakeholders.

For the Ruhr Valley approach of a systems engineering for metropolitan mobility and energy systems we use the very basic analysis and structuring provided by Ropohl in his description of a *systems theory of technical systems* (called "Technology at large") [19]. Ropohl provides a three-layer-model of a general *activity system* – which can be a technical system, any ecosystem or even a biological system. The basic *execution system* deals with the "things" or the interaction with the "real world". The *information system* could be IT or a nervous system in biology. We can easily guess that it would be the layer connecting the things in the Internet-of-Things (IoT). The *target setting system* is a kind of a "brain". In technical systems, it can be seen as the place where data analytics (in some case with "big data" methods – another buzzword) or artificial intelligence methods find their place. It can be the place where the user or the socio-economic system comes in.

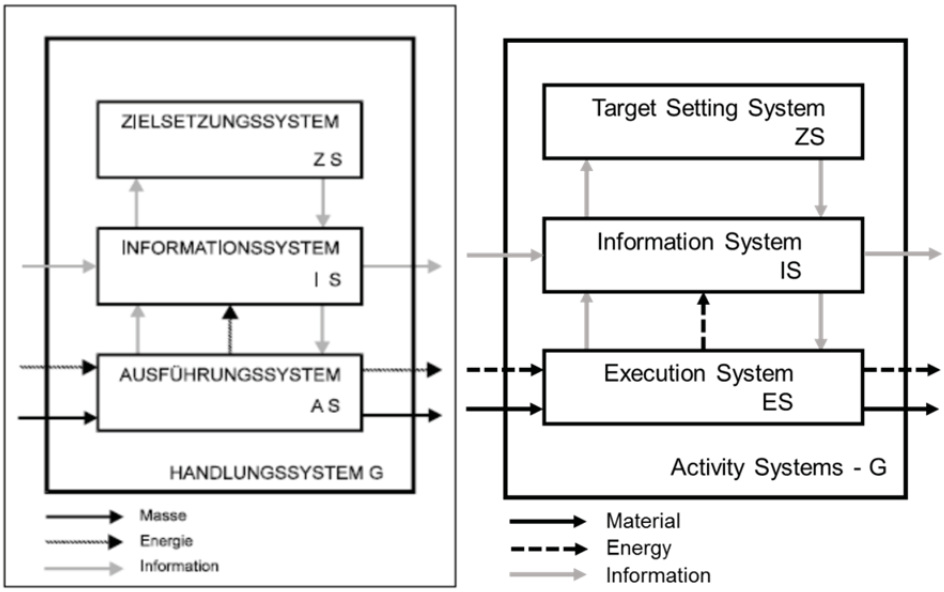

Fig. 1: Original German version (left) of the technology stack according to Ropohl [19] and own English translation (right).

Ropohl offers a very general structure – including a methodology and tools for setting it up. Nevertheless, it is a simple model which is easy to understand for people from different

domains. And it is sufficiently comprehensive and "big" to cover a lot of the relevant aspects. Ropohl's system view corresponds with a much more technical three-layer-model developed for the structuring of intelligent technical systems [2] – the so called "Operator Controller Module (OCM)". This technology stack considers several technical aspects and shows which engineering domains are involved in the development of such systems.

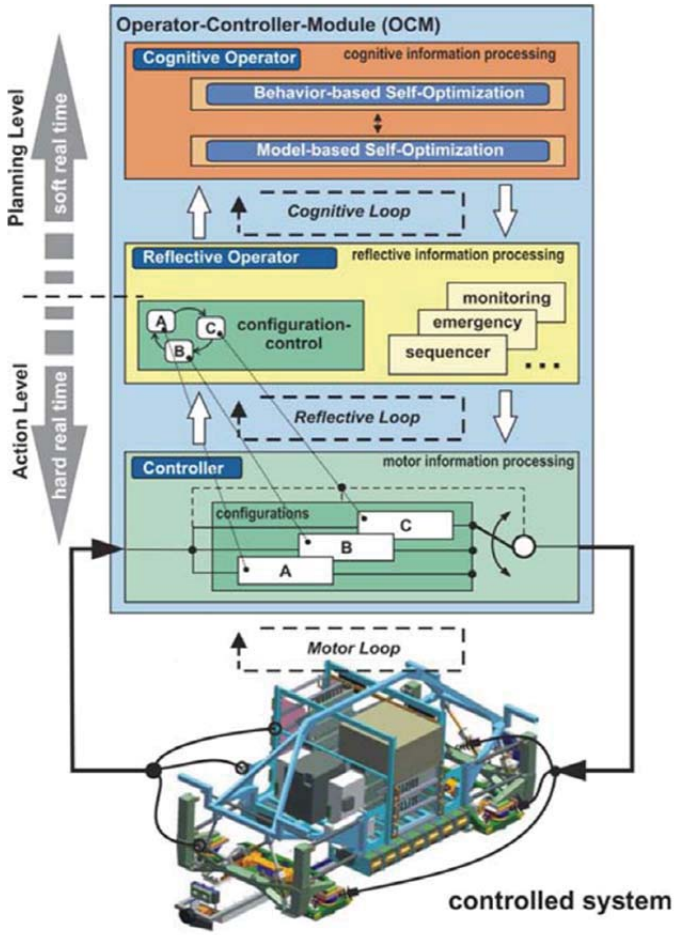

Fig. 2: Technology stack of the Operator-Controller-Module (OCM) [7,8,18]

The OCM technology stack is based on the three layer approach and supports the separation of controllers with hard real time requirements from more complex and strategy oriented planning and controlling tasks. On the lowest level the motor loop is controlled by "classical" controllers. Ropohl's execution system corresponds to the "controlled system" (the technical "thing") and the controllers of the motor information system – controlling the motor loop. These controllers are developed in a model-based-development approach by setting up a mathematical model of the controlled systems and by developing optimized controllers which are simulated with the model and later with the real system (Hardware in the Loop – HiL). This involves engineering domains from mechanical and electrical engineering, embedded systems development, sensor and actuator development and control engineering. Modeling paradigms are data-flow-driven or control-flow-driven. To make the approach flexible, these controllers can be configured with different parameters, the may be exchangeable according to the operation mode and the parameter or controller change may be done during operation (re-configuration). The development and the technology stack for such kind of controllers is state-of-the art. The re-configuration is done by the next layer, the reflective operator. This is a rule-based system with

state machines and service functions, e.g. for emergency notification. While the motor controllers may be attached directly to the different technical sub systems, the reflective operator may be part of the central control unit of the system. The information processing and execution at this level is more event driven and can be addressed with state-chart-based modeling. With the reflective operator, the overall system can be operated and it can be connected to other systems in a network (e.g. the Internet-of-Things). For intelligent technical systems, a more sophisticated layer for planning, reasoning and learning is added - the cognitive operator. This layer can include strategies for self-optimization and machine learning. The user interaction can be added to this layer or to the reflective operator. This layer is intended to fulfill the role of the target setting system according to Ropohl.

For the "systems engineering for metropolitan mobility and energy systems" this layer is also defining the connection to a more sophisticated target setting system which will enable the stakeholders to establish a strategically orchestrated innovation management. The intention is to enable the target setting system to do more than directing the operation of a single intelligent technical system (or a network of such systems).

Innovation Management in the sense of target setting for the future development of the metropolitan region of Ruhr Valley, the respective ecosystems, and target setting for the future research on metropolitan mobility and energy systems (including the systems engineering) is a much broader ambition and will be a major research goal of the RuhrValley cooperation. This involves the analysis and consideration of [14]:

- Market configurations and value chains (especially clusters of small and midsize enterprises – SMEs)
- Ecological and societal challenges (the "great challenges" according to the EU definition)
- Social implications of technology
- Progress in knowledge and technology (including disruptive technological changes)
- Political and regulatory framework

The development of the systems engineering approach in this direction is an own important research field of the RuhrValley university-industry-cooperation. Nevertheless, to form a consistent and comprehensive engineering chain (as requested in [1,3]) it will be closely coupled with the classical systems engineering (synchronized with the INOCSE approach [10,11]). This will go beyond requirements engineering and scenario-based approaches but is intended to use systems engineering methodology for the early phase like CONSENS [7,8]. This *paper covers mainly* the systems engineering methodology and the consequences for the engineering methodology for *the lower layers* which are influenced and driven by the future holistic innovation management approach (as the *upper layers* – covered *in later papers*).

Based on the OCM, the engineering methodology for the different layers can be defined. This leads to the outline of a 9-stage-process called the "smartification process" for intelligent technical systems (see [24], too). This process has been applied in several R&D projects, e.g. for energy systems and automation systems. It defines the involved engineering domains [25]:

- Step 1: Design a technical system with sufficient DoF/flexibility: This involves mechanical engineering, electrical engineering and other classical domains.
- Step 2: Develop a mathematical system model: control engineering, signal processing and mathematical domains are relevant here.
- Step 3: Apply actuators and sensors: this involves physics, microelectronics and microsystems, and embedded systems.

- Step 4: Design of the motor controllers: this is again control engineering and microelectronics for the hardware.
- Step 5: Add reconfiguration & parametrization: this is a combination of control engineering and computer science domains.
- Step 6: Design the rule engine and middleware for the reflective controller: this area is covered by computer science, mainly software architecture (e.g. for IoT-Systems)
- Step 7: Define rules for changing the operating point: in this domain state-chart-modeling is involved, including dealing with concurrency, deadlocks etc., which is mainly computer science and mathematics.
- Step 8: Define a target space for planning level: this involves data science (e.g. data analytics, business intelligence, maybe "big data" if needed). Furthermore optimization, simulation and in certain cases artificial intelligence. These areas are usually covered in business computing, economics and statistics.
- Step 9: Add connectors for planning input data: the planning level is connected to business planning (e.g. to ERP systems).

The whole stack with the attached 9 steps is a tool to define the interdisciplinary cooperation of the respective teams for development and operation of such systems.

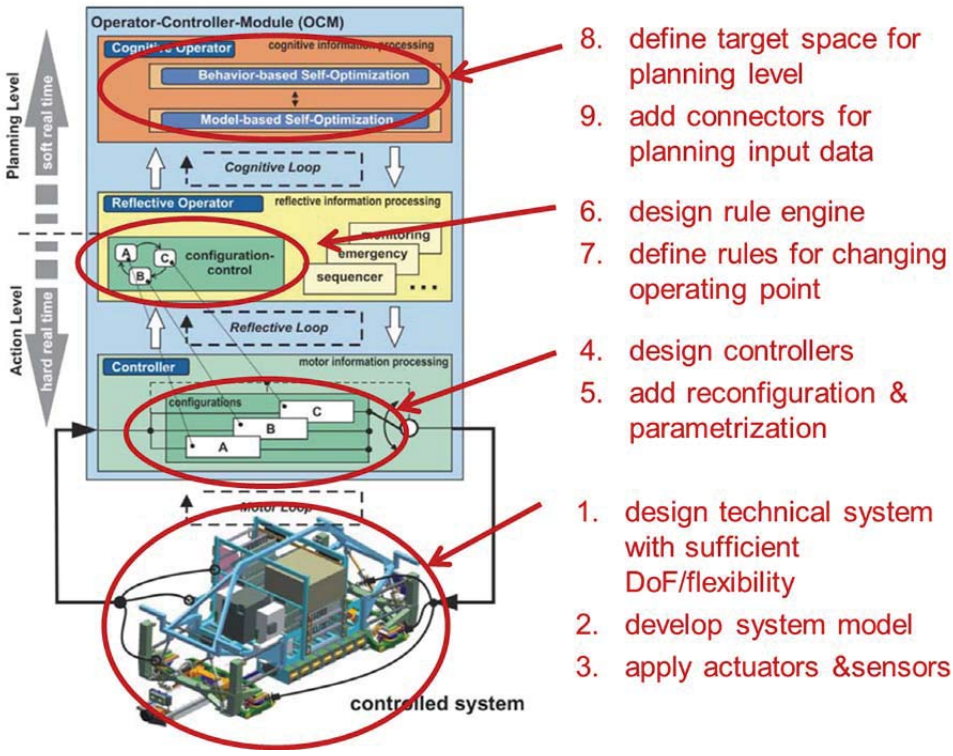

Fig. 3: 9-stage "smartification process" based on the Operator-Controller-Module (OCM)

3. Ruhr Valley at a glance

The Ruhr Valley ("Ruhrgebiet", sometimes also Ruhr Area) is not a strictly defined region but the common name for a metropolitan agglomeration that emerged from cities which grew big during the industrial revolution. It used to be the industrial heartland of Germany with a coal mining and steel industry. Since the 1960's the coal and steel industry disappeared almost

completely. Germany and the state of North-Rhine-Westfalia invested huge efforts into the structural change ("Strukturwandel") which turned the Ruhr Valley into one of the largest scientific clusters in Europe [15][22].

The Ruhr Valley with 53 cities, ~6 Mio citizens, 4,400 square km, is one of the largest European metropolitan regions (which are a major element in urbanization [21]). It was the former German industrial power house (coal, steel, energy). This economical basis disappeared from 1970-1990. Today, it is a research and university region with very high density and a broad scientific and technological profile (energy, mobility (e.g. big automotive suppliers), production (industry 4.0), ICT (Internet of Things), chemistry, mechanical engineering).

The driving factor for the establishment of this science and technology region was the structural change („Strukturwandel") due to the decline of all major industries (coal, steel, energy generation). The Ruhr Valley was the "weak man" in Germany and within the biggest German State North-Rhine Westfalia. The establishment of more than 10 universities (> 200.000 students by today) and a high number of R&D institutions since the 1970ties was a driving factor for „structural change". Ruhr Valley hosts 3 large Technical Universities, several universities of applied sciences (FHs), 3 Fraunhofer Institutes, the German Leading Edge Cluster (BMBF-Spitzencluster) „Efficiency Cluster Logistics Ruhr", the Competency Center eMobility, and major centers for Sustainability and Change Research. Amongst the universities of applied sciences, the Fachhochschule Dortmund, the Hochschule Bochum and the Westfälische Hochschule (Bottrop-Gelsenkirchen-Recklinghausen) are the biggest with ~30,000 students in total. Within this dense science and university cluster, it is straightforward and desirable to combine forces, lever on synergies and discover opportunities jointly. Therefore, the three Universities of Applied Sciences, the Fachhochschule Dortmund, the Hochschule Bochum and the Westfälische Hochschule decided to form the core of a cooperative university cluster to join and multiply their future efforts.

For the Fachhochschule (FH) in Ruhr Valley, there is a specific mission which is very important for Germany. FHs have a low barrier of working with small- and midsize enterprises (SME) and they have a proven track record in such cooperation - even in stimulating the emergence of new SMEs. Such SMEs form technology and value chains by cooperation. Regions of SMEs ("Mittelstandsregion") with specific technical scope (e.g. mechanical engineering) form the backbone of the German economy. The emergence of technology-oriented SME clusters is desirable for the Ruhr Area. The university-industry-cooperation RuhrValley is aiming at that.

4. Systems Engineering in Ruhr Valley

Addressing the major challenges for the metropolitan region Ruhr Valley, it is straightforward and reasonable to apply the holistic systems engineering approach to the area of sustainable metropolitan mobility and energy systems. This involves – of course – a focus on eMobility and on decentral renewable energy provision. Topics like smart grid and modern concepts for public transport play a role. In all these areas the past decades provided a tremendous progress and many technologies are successfully introduced into products already.

The challenge addressed by university-industry-cooperation RuhrValley is going beyond these innovative elements. It aims at the intelligent selection, tailoring, automation and implementation of such systems. The ambition is to find smart ways of connecting solutions and to prove their effectivity and efficiency in real world systems – demonstrators and so-called "real labs". This requires interdisciplinary cooperation of researchers. But it goes again further – into transdisciplinary projects with industry and society. Demonstrators and "real labs" will not be "hidden" within research institutes and universities. The intention is to put them in the places where the solutions are needed and to validate and evaluate them in real operation.

The tool for the transdisciplinary cooperation and the “real lab” for the development, validation and evaluation of the systems engineering approach are projects. RuhrValley will be a projectized cooperation – based on tailored project formats fostering the transdisciplinary cooperation in a comprehensive way. The different project formats are used as tools to orchestrate the project portfolio and to manage the innovation pipeline strategically.

All planned projects position their findings within the three-layer model. They provide solution elements which can be adapted to other areas and which are connectable and interoperable. The idea is that these systems are not “stand-alone” but connected and open to the target setting by the users and the society. This approach is required to address the very diverse application scenarios, user needs and decision processes in a metropolitan region. There is no chance for a centralized planning and a directed operation. Therefore, principles of dynamic adaptation and change, self-organization and cooperation in peer-to-peer networks are required.

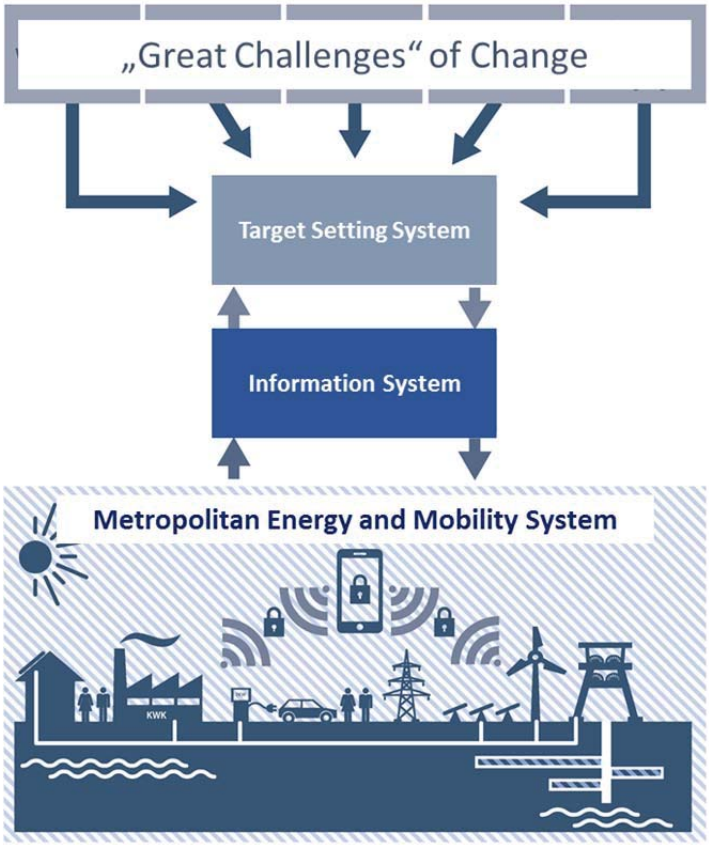

Fig. 4: Technology-stack for “metropolitan energy and mobility systems” according to Ropohl [19] and Operator-Controller-Module (OCM) [18]

One of the pilot projects (NetLab) within the RuhrValley cooperation is the development and establishment of a distributed and virtually connected test laboratory for eMobility components. The virtual lab involves labs in companies and in industry. It will allow for example the test of a motor for an eCar in one lab together with a battery system in another lab at a different location. To develop and establish such virtual test labs, the mastering of the complete technology chain, the setup of a respective information supply chain and the design of a value chain with reasonable business models for all players is required. Technical decisions have to be taken, e.g. on which level of the 3-layer stack which communication has to be done according to real time

requirements. Or the question how to implement “virtualized” energy and material flows between distributed systems. Security and safety are major issues in such systems. To make them usable and available for the SMEs, they need to be easily adaptable and flexible in terms of tailoring to the required test case scenario. Mobile devices-under-test (e.g. test cars) or test systems which are connected to the NetLab-IoT-Stack via future 5G mobile communication are very interesting. Solving these questions requires the setup of interdisciplinary engineering teams combining several steps of the 9-stage smartification process (Fig. 3). Developing the required systems engineering methodology within the *RuhrVally SiME Systems Engineering* is one target, educating engineers and scientists along the process is another aim.

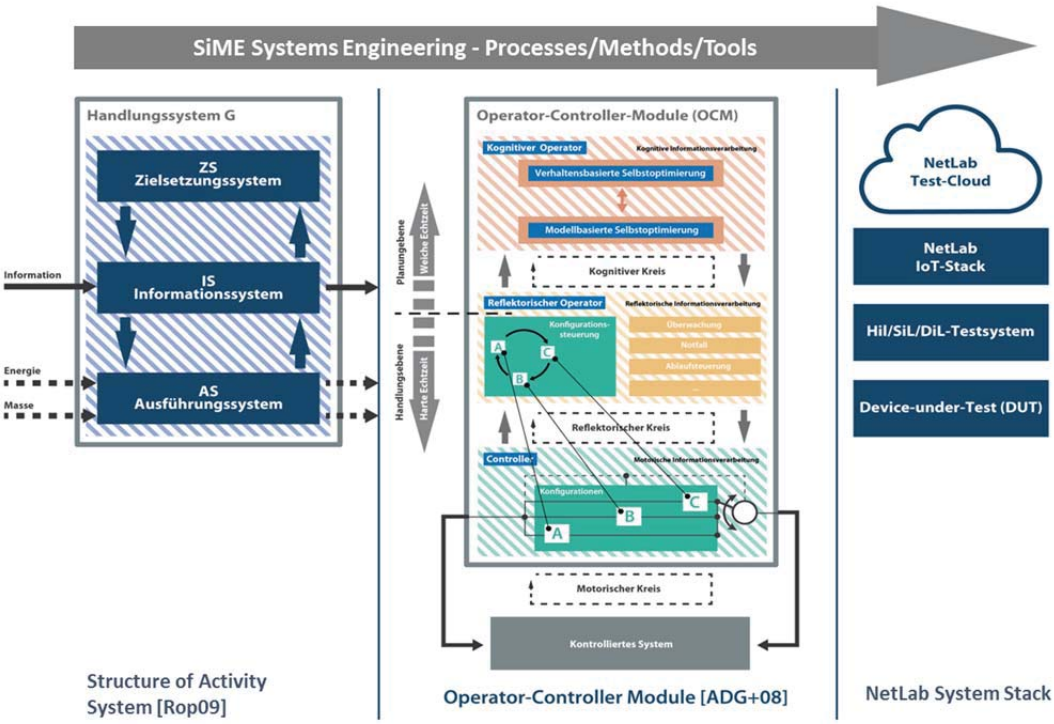

Fig. 4: Application of the Systems Engineering methodology to a virtual test laboratory (NetLab) for eMobility-systems

5. University Cooperation in Ruhr Valley

The three universities of applied sciences which form the scientific core of RuhrValley engage in education on applying scientific findings, on the applied research approach and on the intensive transdisciplinary cooperation with society and industry. With this profile they cover already now a lot of the so-called “Third Mission” of the Higher Education System. This third mission is commonly understood as the combination of three major domains [4]:

- Continuous education (CE): this domain extends the universities mission into live-long learning (e.g. certificate programmes, part-time or distance learning programmes etc.), but also into cooperation with schools and vocational training institutions. The three universities conduct the joint ***Ruhr Master School of Applied Engineering***[2] – funded by the Mercator Foundation (Stiftung Mercator)[3].
- Technology transfer & innovation (TTI): this covers all activities to turn scientific findings into innovations in society and industry. To address this challenge, the

[2] www.ruhrmasterschool.de
[3] https://www.stiftung-mercator.de/en/

university-industry cooperation RuhrValley[4] is set up – based on funding of the German ministry BMBF within the programme FH Impuls[5].

- Social engagement (SE): this broad domain is including all activities of the university as a player within the society (e.g. cultural activities, service learning, but also topics e.g. in community outreach and diversity). Examples of the cooperation of the three universities in this domain are projects like "Studienpioniere" and "Talentscouts".

The third mission is a topic for meta-research about the role of universities with a broad variety of concepts [4][9][18]. It involves strong interaction of university-industry-government (Triple Helix) and it is an important expansion of the scope of the university – even a new mode (Mode 2) of the role of universities [6].

The ***university-industry cooperation RuhrValley*** is a "third mission" element, connecting university research via the *technology transfer & innovation (TTI)* with industry and society. The intention is to create a cluster covering the complete technology and value chain and therefore providing an innovation ecosystem. To make the cooperation "live", an orchestrated project portfolio is used which puts the players with tailored project formats into intensive interaction. Therefore, TTI is not a single-direction standard process anymore (with a one-way "over-the-fence" approach of putting university innovations into the window and hoping for entrepreneurs coming and picking them) but a projectized approach of joint, transdisciplinary development projects from innovation to business (which can be a product or even a new company). Communication formats allow the broader society and industry to influence the project pipeline – generating the required Knowledge, Innovation and Consensus Spaces [6].

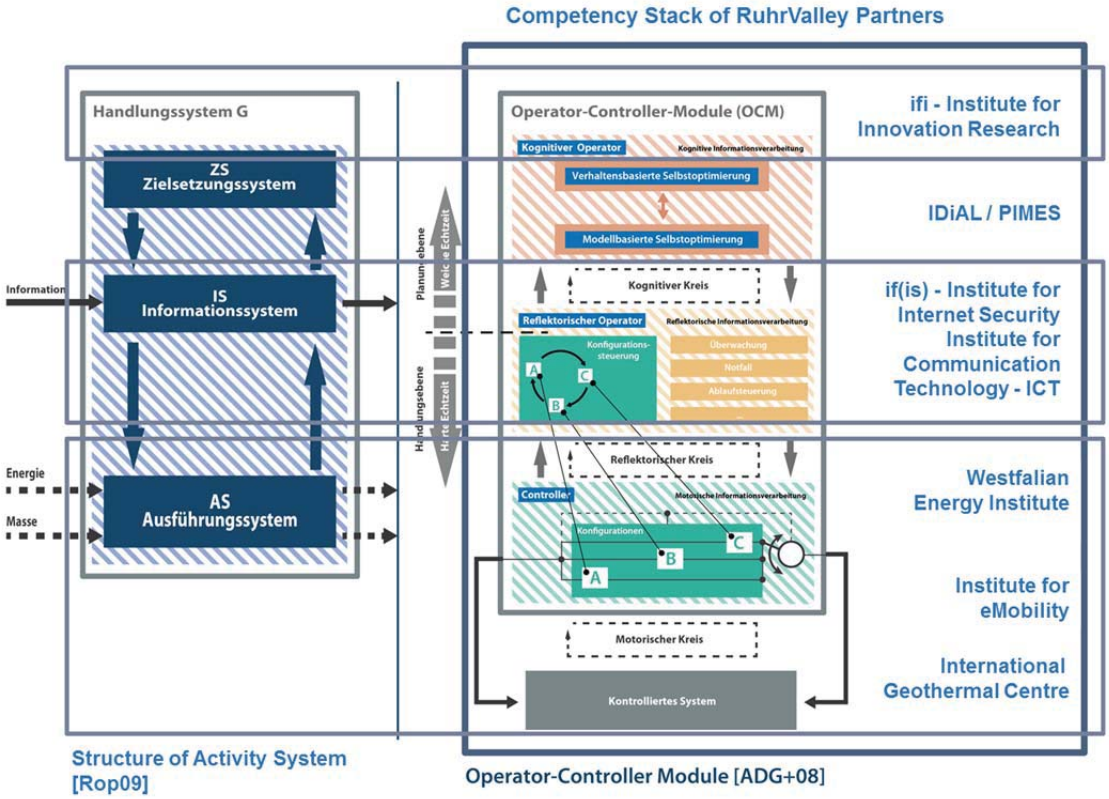

Fig. 5: University-industry-cooperation "RuhrValley", based on 7 research institutes from 3 partner universities – covering the complete technology chain

[4] www.ruhrvalley.de
[5] https://www.bmbf.de/de/starke-fachhochschulen-impuls-fuer-die-region-550.html

For the implementation of this approach, seven university institutes from the three partner universities have been selected which cover the whole technology chain. Furthermore, more than 40 companies have become initial members - covering the whole value chain. More than 15 of the companies are more or less spin offs of the 7 institutes. This is the basis of a SME cluster ("Mittelstandsregion") on metropolitan mobility and energy systems.

The university-industry-cooperation RuhrValley is complemented by another relevant pillar in teaching and education – the ***Ruhr Master School***. The Ruhr Master School is a cooperation of the universities of applied sciences in Dortmund (FH Dortmund), Bochum (HS Bochum) and Gelsenkirchen (Westfälische Hochschule). The aim is to establish a joint study offer with more than 15 Master's programmes in engineering. This will provide a major source of excellent experts for the industry in Ruhr Valley. According to the philosophy of the Master education at FH, the programmes are conducted in close cooperation with industry. They follow a transdisciplinary approach to achieve a very good employability.

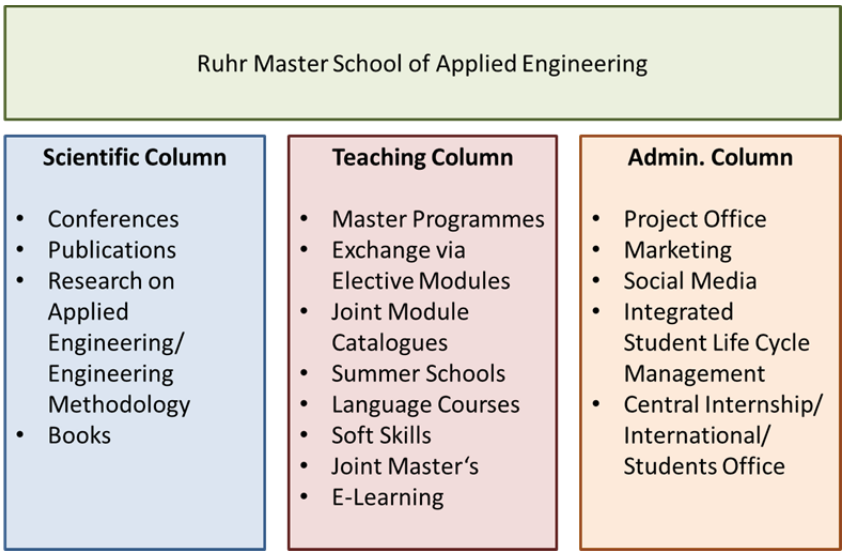

Figure 6: Scope of the Ruhr Master School of Applied Engineering

The educational concept is to conduct the Master's education in a projectized way, too. Meaning, students from different Master's programmes meet in interdisciplinary teams working on solving problems from the RuhrValley. A tailored portfolio of educational elements (e.g. summer schools, block weeks, workshops and case studies) combined with several own research projects embedded into the programme allow the industry partners to closely interact with the students. The competences taught by the Master's programmes cover a combination of areas of the 9-stage "smartification process" (Fig. 3) enabling the students to interact and work in interdisciplinary work. The early exposure to "real world problems" leads to a high competence in transdisciplinary work. This is only possible in a Master School, not in a single Master's programme or in a faculty. For universities of applied sciences the educational goal is to foster student's employability by enabling them to work in this way. That is slightly different from classical university, where the further development of a specific scientific domain is the main goal. Therefore, Master Schools are the most promising element in the future development of education in universities of applied sciences. The approach of virtual Master Schools (spreading over Master programmes at different universities) is a tool for application domain focused education (see thematic Master Schools for the European Union Knowledge and Innovation Communities, e.g. the InnoEnergy Master School [13]). Connecting the Ruhr Master

School with the university-industry cooperation RuhrValley is following the same approach. Interaction formats from RuhrValley like workshops and conferences are done with students and lecturers from the Ruhr Master School. Industry experts teach in the Master's programmes, students do their research in RuhrValley projects. The graduates as future employees of the RuhrValley companies are the most powerful way of technology transfer & innovation (TTI). The continuous participation of entrepreneurs and employees (via HR personal development) of RuhrValley in the training programmes of Ruhr Master School (e.g. part time or certification programmes) are continuous education (CE) activities. Therefore, RuhrValley and Ruhr Master School are a natural combination of university education and research with the "Third Mission".

6. Conclusion and further research

The university development agenda for the three Ruhr Valley universities offers a big chance in developing the role of universities of applied sciences, in developing the Ruhr Area as a science and technology region and in impacting the change of the socio-economic environment in a very sustainable way. Nevertheless, many of the approaches might be recommended already for some years [15,18,22] but have never been applied at that scale in reality. Therefore, the coming years are also building a "real lab" for the future development of Higher Education. The universities will establish an own meta-research on efficiency and effectivity of the activities. For this purpose, a strategic planning and controlling process with a balanced scorecard and the definition of a number of valid key performance indicators (KPI) is established. The process is linked with the involvement of industry, society and citizens in several aspects (e.g. in steering boards, but also in communication formats). The German BMBF and the Stiftung Mercator are doing additional research ("Begleitforschung"). An own PhD group (embedded into an international programme with sponsorship by DAAD) is starting to work on that, too. Several audits with external experts are completing the portfolio of meta-research. Therefore, we expect to generate a big portfolio of data and results which allows correcting the direction of the activities and developing new approaches.

As further research, a formalization of the "RuhrValley SiME Systems Engineering" and the "Smartification Process" as part of Systems Engineering Methodology is required. Furthermore, a continuous design flow and tool chain for the engineering of Intelligent Technical Systems can support the process. These activities are also considered to be relevant for the PhD group and for further research projects. They will also generate significant content for future teaching modules within the Ruhr Master School. Finally, the project pipeline of RuhrValley is expected to be filled up with a continuous flow of future projects on metropolitan mobility and energy system which results in innovations, products and new business for the Ruhr Valley.

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Improved Model of a Financial Sustainability in Organization

Serhiy Hutsal, Anatoliy Sachenko
hutsal.serhiy@gmail.com, as@tneu.edu.ua
Ternopil National Economic University
11Lvivska street, Ternopil, Ukraine, 46000

Keywords: financial sustainability, conceptual model, profit, pillar

Abstract: Improved model of a financial sustainability in organization was proposed. Additional categories - the existence of profit with corresponding connections between model components and prognosis of economic risk parameters were introduced into four main pillars of financial sustainability: financial and strategic planning, income diversification, accounting-administrative procedures, own income generation.

1. Introduction

In recent years an urgent need has arisen to create the concept of financial sustainability of projects. Many (from 50% to 90%) of projects in different countries of the world collapsed, that caused the loss of millions of dollars for project organizations [5]. This result is connected with the loss of financial sustainability. Therefore project managers are looking for ways to achieve concepts integration to ensure sustainability in project management. In this context, the financial sustainability is being understood as an adoption of global strategies and solutions that meet the needs of the project and stakeholders [2]. This important task compelled many experts on project management to find out the factors that influence sustainability of the project and, consequently, the final result.

One of the approaches is to force project managers to contribute to sustainable management practices. The second approach is based on the thesis that further development of the profession of project manager requires project managers to take responsibility for sustainability. According to this the project managers must consider widely their role and take a responsibility in terms of the financial sustainability for the final result [1].

The third approach offers the maturity model for integrating the sustainability in project management and providing a way of transforming the complex concepts into organizational capabilities and a competence improvement for the potential development [3]. In terms of "depth" vision, this approach can be interpreted as a four-level maturity model (Fig 1). The first logical level is the level of resources. The object of the second level is business processes where these resources are used. Then, on the third level it is shown how the products or services are delivering to the business model. The fourth and last level takes into account not only process or business model to deliver products and services, but its own products and services as well.

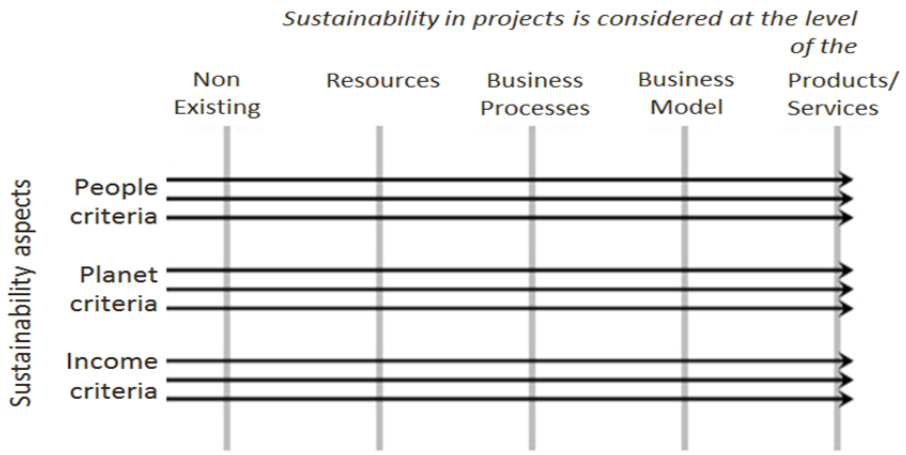

Figure 1.Maturity model [2]

However, it should be noted, that approaches [1-3] serve mostly on the theoretical basis, having limited practical possibilities to solve specific issues of the financial sustainability properly.

2. Improved Model of the Financial Sustainability

In order to eliminate mentioned above drawbacks, the authors developed a conceptual model (Fig 2) based on the modified approach [4]. This model includes four main pillars of financial sustainability such as: 1-financial and strategic planning, 2-income diversification, 3-accounting-administrative procedures, and 4-own income generation [4]. In the first pillar the strategic planning is a mechanism that helps to explain the purpose and objectives of the organization and prioritize the actions needed to implement them. However, the strategic planning is running in a purely conceptual

level, it has a weakness - it does not take into account resources available to implement selected strategies. It is important therefore to engage in parallel a process of financial planning to reinforce the actions described in the strategic plan, by quantitative indicators. Moreover authors proposed to introduce in this pillar a prognosis of economic project's parameters (see a Fig 2), based on the method of the enlarged assessment of the project's sustainability, and taking into account the both risk factors and uncertainties [6].

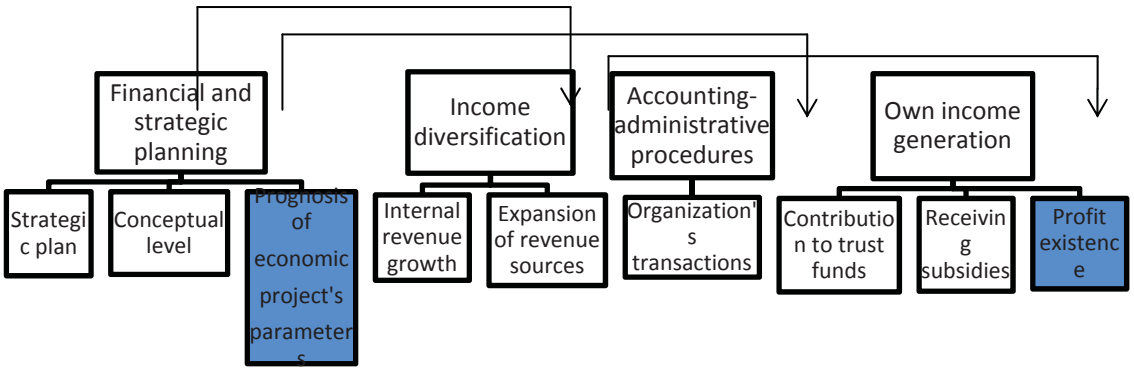

Figure 2. Improved model of the financial sustainability in organization

The second pillar is a diversification of the income. It's considered as not only the growth of internal incomes, but also as the expansion of income sources that provide project's funding. Even when an organization has the twenty sources of funding, it is still extremely vulnerable if a significant part of the budget depends on one of them only. Any change in the investment of donor could cause a serious crisis. At least 60% of the total budget organizations have to come from five different sources [4]. The third pillar includes accounting and administrative procedures, which must meet the organization's needs. Regardless of the scope and structure, these procedures should include the transaction of organization, that later will allow us to see the character of the project in general. This type of accounting is known as the designed one or donor-based, and it's highly susceptible to the human error.

The fourth pillar of the financial sustainability is the own income generation, as a way to diversify own sources of the income. The income could be generated in two ways: by contributing to trust funds or by receiving subsidies [4]. Authors proposed to introduce here an additional category - the existence of profit (see Fig 2). This is substantiated by the following:

i) according to the «The P5 Standard» in projects of the sustainable development, the essential factor is the profit presence as a guarantee of resource non-usage for future generations [8].

ii) the expected profit should ensure the financial sustainability throughout the project life cycle, not just as the final result [7].

iii) profit existence is a separate category of the fourth pillar enabling to implement the project within the financial opportunities of stakeholders - investors, sponsors, and so on.

Finally, in order to ensure the financial sustainability of the project during its life cycle, it is necessary to balance the four pillars of the financial sustainability (see Fig 2) per each level of the 4-levels maturity model (see Fig1).

3. Results and Conclusion

The authors proposed the improved model of the financial sustainability in organization through the introduction of the two additional categories - prognosis of economic project's parameters and the profit existence with corresponding connections between the components of the model. This will enable using its own funds to ensure the financial needs of the project in the future as well as reduce the dependence of the project ultimate outcomes from external investors and sponsors.

The project is considered sustainable if a balance is kept for all pillars of the financial sustainability per each stage of the project life cycle at all levels of the improved model, and its own generated profit, as a necessary category of the fourth pillar, will provide the financial independence.

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Analyzing motivation pattern of employees, a new practice to optimize organizational project management maturity

Arash Koochakan

Arash.Koochakan@gmail.com

MBA, Student of European Master in Project Management

Fachhochschule Dortmund

Dortmund, Germany

Keywords: Best Practice, employee's motivation pattern, Job performance, organizational project management maturity, organizational effectiveness,

Abstract

Effectiveness of organizational project management could be a sign of competitive advantage for organizations in today's competitive economy. In order to be more effective, organizations should assess the current level of their capability and compare them with best Practices to understand their level of their maturity and plan for their improvement. The purpose of this paper is to highlight the importance of studying motivation pattern among employees in organizations due to its affect on their individual and organization's performance, which can finally results to an approach to define new Best Practice to optimize the process of determining maturity level of organizational project management.

Introduction

In a changing business environment, knowing how to develop appropriate strategies to navigate these changes is a must. In fact, in order to survive in a competitive world, organization should frequently design new proper strategies to increase their performance (Manzoor, 2012, p.1). It is clear that a new strategies or change in strategies will bring new strategic initiative by itself. Cabrey and Haughey(2014, p.4) recognized project and program as drivers of strategic initiative for organizations. Applying strategic changes have been done in 86 percent of cases through standard practices in program and project management (Cabrey,Haughey, 2014, p.7).

OPM3 in 2003 was introduced by PMI which filled that gap between successful project management and organizational strategies (PMI/OPM3, 2003, p. xiv). It helps organization to improve their project management maturity by assessing their current level of project, program and portfolio management capabilities against defined standards-Best Practices.
Aquinas (2008, p.11) defined organizational effectiveness as degree which organizations can understand them to find their position in achieving their goals. In this context, effectiveness in organization can be viewed from individual, group and organization level. In individual level the individual effectiveness is to somehow realized as task performance of employees (Aquinas 2008, p.70). There are many scholars, books and guidelines which emphasized on importance of employees motivation pattern and level and their impact on employees performance and on

organizational effectiveness (Manzoor, 2011), (Sims, 2007), (Dobre, 2013) and etc. In the field of project management, many notes and recommendation can be found which emphasized on identification and assessment of different motivating factors on employees for successful project management (ICB4,2015, p.291,301,308) ,(PMBOK,2013, p.273).

Employee's motivation

Motivation at work is defined as the psychological processes that conduct and energize action to specific job, task or project (Campbell & Pritchard, 1976, pp.63-130). During the last century through evolution of management theories different motivation theories have been introduced. Normally motivation theories are categorized into content and process theories (Robbins, Judge, 2013, pp.202, 238). Process theories of motivation describe the process which caused that motivation to occur while content theories focus more on the factors which can cause motivation on employees. Looking among content theories of motivation to find different tangible factors that can result to motivation in employees as well its pattern among them, it could be found that Herzberg's two-factor theory and Kovach's ten job-related motivating factors (Kovach, 1987, pp.58-65) which was based on the Herzbergs theory, are more comprehensive than other theories. There are some reasons which support its advantage over others:

- In Herzberg Two-factor theory, all factors which can result to motivation on employees as well as factors which deficiency on them in organization will result to dissatisfaction are clearly expressed in tangible terms (Herzberg, 2003, p.7).
- In Herzberg's view, different factors whether they are job related or extra job related have been separately categorized so regarding to this categorization intrinsic motivation as well extrinsic motivation of employees can be measured (Tietjen and Myers, 1998, p.226).
- Using Herzberg' theory enables managers to investigate other view of factors which can influence employee's behavior. In fact, Two-Factor theory can be used to study the concept of job satisfaction in organizations and help to distinct between satisfying factors in job which increase satisfaction and dissatisfying factors which rise dissatisfaction (Manisera, Dusseldrop, Vander Kooj, 2005 , p.1,4).

Despite criticism on Two-Factor theory by (House, Lawrence, 1967), it was a foundation of some researches which was based on the effect of motivating factors on employee's performance. Kovach (1987, pp.58-65) identified what motivating factors can motivate employees and ranked them in accordance to their importance. Further she did continual studies which were done base on Hertzberg's framework and finally identified ten job-related motivating factors which have been used in many researches related to employee's motivation in different industries (Kovach,1995) , (Bessel and Kepner,2002), (Roe,2009) and etc. Her finding further was supported by other studies of motivating factors by Wiley (1995) and Lee Ross and Darren (1995). Since similar results to Kovach's motivating factors have been found, ten job rewards in her study became well known as Kovach's ten job-related motivating factors. Considering these factors which are shown on table 2.1, it can be seen that they are to a great extend synonym to what Hertzberg has recognized (Adillah, 2000).

Table 1. Comparison of Hertzberg and Kovach's motivating factors.

Motivator-Hygiene Theory	Kovach motivating Factors
Intrinsic Factors	Opportunity for career growth
	Feeling of being involved
	Interesting work
	Full appreciation of work
Extrinsic Factors	Sympathetic help with personal problem
	Company loyalty to employee
	Good working condition
	Tactful discipline
	Job security
	Good wages

Job performance and organizational effectiveness

Human resource management is a fundamental issue which can result to the success of any organization (Sims, 2007, p.4). Employee's performance management is a common subject in studying disciplines related to human resource management and there are many scholars which identified the role of employees performance on success of organization in achieving their goal and objectives, (Colquitt, LePine, Wesson, 2010), (Uzonna, 2013), (Ivancevich, 2010) and etc. In fact, it could be said that one of HRM policies is to improve performance of employees to fulfill their task effectively and align individual performance to organizational goals and objectives. Aquinas (2008, p.70) recognized the process which link individual performance to organizational performance. In this process individual performance is a variable which impact group performance and finally performance of groups affect organization performance.

Employee motivation and performance

Aquinas (2008, p.14) identified employees satisfaction as a variable which should be measured to ensure well effectiveness of organization. Manzoor (2011, p.1) defined employee's motivation as one of fundamentals which can impact their performance. There are many other scholars that studied correlation of motivation factors and performance among employees and they indicated that different motivation factors-motivation pattern- exist among employees and these factors impact their performance differently (Ummah, Mahroof, 2014, p.1), (Sims, 2007), (Dobre, 2013, p.7), etc.

Correlation between findings and conclusion

As can be seen in literatures of this report, organizations use different project, program and portfolio to reach their goals. Also, their level of effectiveness depends on how much they are effective in performing their project, program and portfolio. According to OPM3 (PMI, 2003, p.16), to assess the maturity of organization in performing project, program and portfolio, they assess their current capability using different KPI which already set for the organization and compare them with Best practices. This process is shown in Figure1.

Figure 1: Best practices, capability and KPI confirm the attainment of outcome (PMI-OPM3, 2003, p.16)

Considering all literatures in this report and analyzing different variable and their correlation with each other, we can reach the following results.

1- The motivation factors and their strength -motivation pattern- can influence individual performance which subsequently affects group and then organization's performance and effectiveness. Demonstration of this process can be seen in Figure 2.

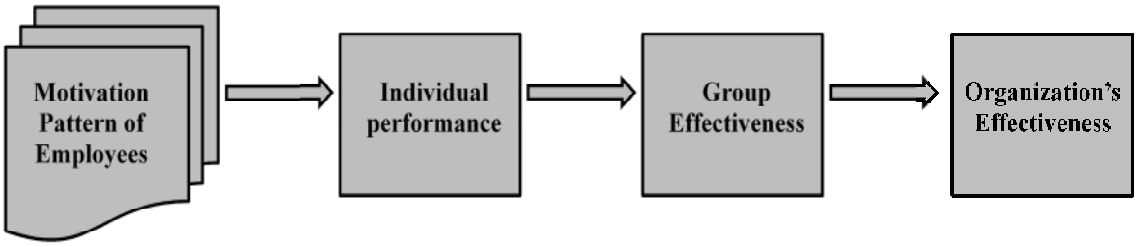

Figure 2: The process of impact of employee's motivation on organization's effectiveness

2- According to definition of Best Practices in OPM3 (PMI, OPM3, p.13), we can find that Best Practices are optimal recognized way in industry which increase probability that organization become successful in achieving their goals and objective. Therefore, they can act as path-maker for organization to reach proper level of effectiveness.
As Figure 3 shows, Best Practices in OPM3 framework and Motivation pattern of employees playing the same role by which an organization can increase its effectiveness to reach strategic goals. By integration of two processes, it can be said that:
"The concept of analyzing motivation pattern of employee can be considered as a Best Practice by which organizations can determine the level of their maturity in performing their project".

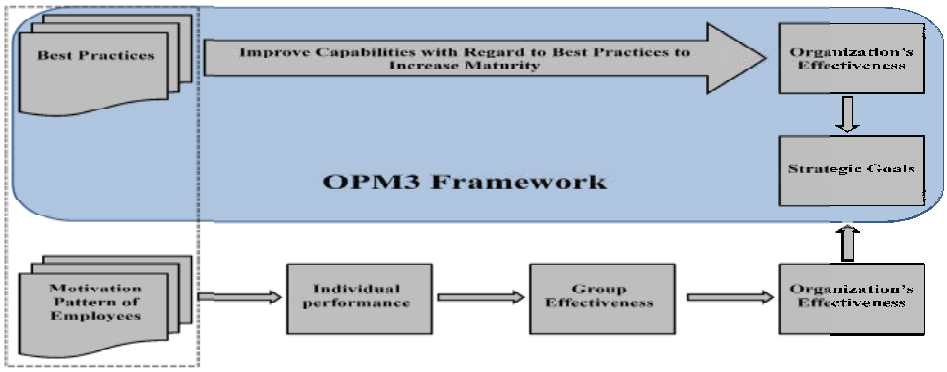

Figure 3: Integrating OPM3 framework with the process of affecting motivation pattern of employee on organization's effectiveness

3- The importance of studying motivation pattern of employees specifically can be highlighted in project portfolio management. One of the objectives of portfolio management is allocate resources to different projects in organization (PMBOK, 2015, p.10) and human resource is one them. Since different organizational structure such as functional or matrix structure exist, Different pattern for staff engagement in projects can be determine among employees who work in different functional area (PMBOK, 2015, pp.22-25). Fulfilling staff acquisition process for portfolio requires criteria and due to different nature of each project

this criteria could be different from one project to another. Thus, it could be said that project portfolio manager require some criteria to acquire competent staff for their different projects. Gordon (2001, p.26) recognized a motivation as a critical factor for staff acquisition.

Since Kovach ten jobs-related-motivating-factors are tangible and measureable, they can be used as criteria to assess motivation pattern of employees. Determining these ten factors and their significant-motivation pattern- among employees periodically enable portfolio managers to be aware of employees tensions to do tasks. Therefore, by using this knowledge, they can choose more competent staff for projects. Regarding to importance of determining motivation pattern among employees, the existence of a Best Practice to realize this pattern will help organization to increase their maturity in portfolio management.

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Enterprise Project Management Office (EPMO) for Project Management Efficiency
A Methodology to Achieve European Electricity Production Target by 2030

Ekomenzoge Metuge

E-mail: ekomenzoge@yahoo.co.uk

PhD Candidate

University of the Basque Country (UPV/EHU) Bilbao Spain

Key words: Project management office, Enterprise project management office, Sustainability, EU28, PRINCE2, Energy and Electricity Production, PMBOK®

Abstract

Electricity and energy production in EU28 has so far been technically panned. Electricity and Energy production management projects and programmes should not sourly or purely technically be planned; it requires a multidisciplinary approach that will combine skills from engineering and management discipline (Petrecca, 1992). To achieve electricity and energy efficiency within EU28, this research write-up which is part of my doctorate (PhD) research, will be advocating for the development of a project management methodology call Enterprise Project Management Office (EPMO). This is a propose methodology I believe will help companies in the electricity and energy sectors to be able to achieve the European Electricity Production Target by 2030. The EPMO, I will call it the "Electricity Production Efficiency Gap (EPEG)" to help achieve the target as it will be explained below.

Introduction

With the increase in the oil crises in recent years 2010 - 2015, thus affecting energy and electricity production, it has created opportunities for producers to reduce production thus pushing for reduce consumption has given rise to many studies of energy and electricity production efficiency.

"Energy-to-GDP" ratios has been and is still use locally and internationally in measuring energy and electricity production and its efficiency in member state EU28 national economy; thus prompting a group of research to came together trying to discourage use of such an indicator "(Schipper et al., 1992; Patterson, 1993; Ang and Choi, 1997; Bossboeuf et al., 1997; IEA, 1997)".

Some energy analysts are demonstrating that some factors other than electricity and energy efficiency are constantly affecting a lot more changes in electricity energy intensity; factorization techniques or analysis of decomposition are constantly been developed to better understand a way to intensity the effect of a better estimate of which electricity and energy efficiency can be improvements. Ang (2004) has provided a review of some of the different aspects of these or some of these techniques of evolution.

A decade and a half ago (2000-2015) energy and electricity management production has undergone a series of different phases and approaches (Piper, 2000). Electricity production within the EU28 has not been smooth thus the fair of electricity efficiency target for 2040 might be threatened.

The achievement of an efficient electricity and energy EU 28 will be hard to reach with a multi methodological approach. After a few years of scanning around, the EPMO application and implementation approach is been considered the best methodology capable to provide and successfully deliver projects outcome just-in-time and in cost and scope to helping meet project objectives of big and small companies in the production of electricity to meeting the target of 2030. This methodology will be considered as that GAP-NEED to be analyst such that it will be used to close the gap lacking to increase electricity and energy production efficiency in meeting the target 2030. See figure 2 below.

Electricity and Energy Production Trend

A lot more have been written by many scholars in this sector "Electricity and Energy Production Trend in the EU". I am just mentioning so as to draw our attention on the subject before getting deep into applying and analyzing the methodology. Electricity production and generation in the EU28 from the year 2000 up to 2015 has gotten a range of a variety of energy sources[1]. (See table 1 and figure 1 below). Electricity production within these EU28 has not been stable, with production varying from year to year. More on the variation of electricity production can be seen in table 2 below. Because of this, this research is stating that electricity and Energy production management projects and programmes should not sourly or purely technically be planned; it requires a multidisciplinary approach that will combine skills from engineering and management discipline (Petrecca, 1992). To achieve electricity and energy efficiency, this research write-up will be advocating for the development of a project management methodology call Enterprise Project Management Office (EPMO). Energy and electricity production companies in the EU28 have been using different management methodologies in managing electricity production. This write-up will not be analyzing some of the different project methodologies in use but will be drawing your attention on how the application and implementation of an EPMO will help to bring about the closing of that GAP-NEED in order to bring about electricity production efficiency that will help EU28 meet production target by 2030.

'Implementing Organizational Project Management; A Practice Guide (PMI, 2014)', organizational project management personnel's and practitioners should have an idea and know also how to better integrate their organizational 3P's (Programme, Project and Portfolio) management with other methodologies like the EPMO.

Gone are the years when many organisations were trying to implement what project managers call 'off-the-shelf' management type of methodology 'one-size-fits-all' to all their projects and programmes. The importance of why a project management methodology that over sees planning, delegating, monitoring

[1] http://ec.europa.eu/eurostat/statistics

and controlling of all aspect of projects and programmes is of great importance, (PRINCE2; page 4, 2009).

Organisations have to commit themselves to knowing and understanding why they have to introduce a particular project management methodology. By so doing, these practitioners in project management will be successfully delivering and achieving better projects. As with the case of electricity production efficiency within the EU28, and to meet its production efficiency target by 2030, a rigor project management methodology has to be applied and implemented that will modify management practice to better coordinate small PMO´s and resources within their companies.

Energy			
Electricity production, consumption and market overview			
Figure 1: Net electricity generation, EU-28, 2013 ([1])			
(% of total, based on GWh)			
	(GWh)		
Combustible fuels	1.545.964		
Nuclear	830.950		
Hydro	396.123		
Wind	233.426		
Solar	84.686		
Geothermal	5.561		
Other	4.589		
([1]) Figures do not sum to 100 % due to rounding.			
Source: Eurostat (online data code: nrg_105a)			

Table 1: Source Eurostat 2016

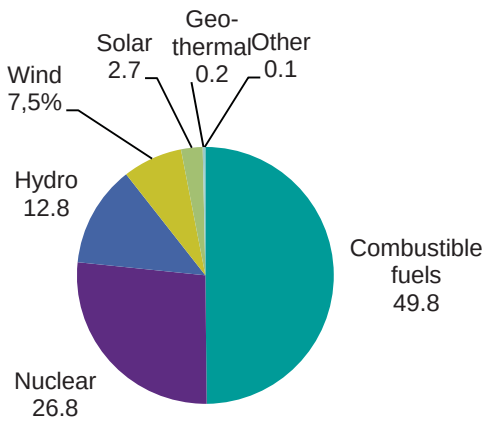

Figure 1: Source of electricity and energy production within EU28 (source, Eurostat 2016)

	1990	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**Share in EU-28, 2013 (%)**
EU-28	2.432,1	2.584,1	2.872,9	3.153,4	3.199,3	3.130,2	3.128,1	3.101,3	100,0
Belgium	67,3	70,6	80,3	83,4	91,4	86,7	79,9	80,2	2,6
Bulgaria	37,5	37,4	36,9	40,3	42,2	45,8	42,9	39,8	1,3
Czech Republic	58,1	56,9	68,0	76,2	79,5	81,0	81,1	80,9	2,6
Denmark	24,3	34,7	34,4	34,4	36,9	33,5	29,2	33,1	1,1
Germany	508,6	498,9	538,5	582,7	594,8	576,9	592,7	596,7	19,2
Estonia	15,4	7,6	7,6	9,1	11,7	11,7	10,5	11,8	0,4
Ireland	13,7	16,8	22,7	24,8	27,4	26,4	26,5	25,1	0,8
Greece	32,1	38,4	49,9	55,7	53,4	53,9	53,7	52,6	1,7
Spain	144,6	159,1	214,4	282,1	291,0	283,3	286,6	274,5	8,9
France	401,2	472,6	516,1	550,2	544,3	536,5	541,3	548,7	17,7
Croatia	8,3	8,5	10,3	12,0	13,6	10,4	10,2	13,0	0,4
Italy	205,1	229,2	263,3	290,6	290,7	291,4	287,8	278,8	9,0
Cyprus	1,9	2,4	3,2	4,1	5,1	4,7	4,5	4,1	0,1
Latvia	5,9	3,5	3,7	4,4	6,1	5,6	5,7	5,8	0,2
Lithuania	26,3	12,4	10,0	13,6	5,3	4,4	4,7	4,5	0,1
Luxemburg	1,3	1,2	1,1	4,1	4,6	3,7	3,8	2,9	0,1
Hungary	25,9	31,3	32,3	33,2	34,6	33,5	32,3	28,0	0,9
Malta	1,0	1,4	1,8	2,1	2,0	2,1	2,2	2,1	0,1
Netherlands	69,4	77,6	86,0	96,2	114,3	109,0	98,6	96,8	3,1
Austria	48,4	54,9	59,1	63,5	69,3	63,8	70,5	65,9	2,1
Poland	123,4	127,4	132,2	143,6	143,5	148,9	147,6	150,0	4,8
Portugal	27,3	31,9	42,2	45,0	52,8	51,1	45,3	50,4	1,6
Romania	56,7	52,9	48,6	55,5	55,9	56,5	53,7	54,1	1,7
Slovenia	11,2	11,8	12,8	14,1	15,4	15,0	14,7	15,1	0,5
Slovakia	23,0	23,4	27,7	29,3	25,4	26,1	26,1	27,2	0,9
Finland	51,6	60,5	67,3	67,8	77,2	70,4	67,7	68,3	2,2
Sweden	142,5	144,2	141,6	154,6	145,3	146,9	162,8	149,5	4,8
United Kingdom	300,1	316,6	360,8	380,5	365,6	350,8	345,5	341,3	11,0
Norway	120,8	122,6	142,3	137,4	123,1	127,1	147,2	133,6	-
Montenegro	0,0	0,0	0,0	2,8	3,9	2,5	2,7	3,8	-
FYR of Macedonia	5,4	5,8	6,3	6,5	6,8	6,3	5,8	5,7	-
Albania	3,2	4,4	4,7	5,4	7,6	4,2	4,7	7,0	-
Serbia	38,2	32,5	31,3	34,6	35,7	35,8	34,2	37,2	-
Turkey	54,2	81,9	118,7	155,5	203,0	217,6	227,7	229,0	-

Table 2: source; Eurostat 04/04/2016 (Electricity production in EU28)

Methodology

As defined by "A Guide to the Project Management Body of Knowledge (PMBOK® Guide) (PMI, 2013b)" methodology is "a system of practices, techniques, procedures and rules" (p. 546).

Specifically, we can define project management methodology as a discoverable set of documented whole set of tools, techniques, policies, practices, templates, providing a set of guidance on ways for which we can projects in our establishments. Methodologies varies from minimal to extensive, heavyweight to lightweight, simple and straight forward and complex. Although there is no one single methodology that can be applied to an entire project management lifecycle, the EPMO methodology is such that is acts as a large body while the rest will be as subsets to it. Overseeing the implementation and running of all other methodologies the organisation is using within some of its projects. PMBOK and PRINCE 2 are the main project management standard from which we derived our methodologies.

Why EPMO Methodology Application

EPMO Project Management Methodology works in the promotion of and delivery of high quality products that usually meets the needs of its customers'. EPMO projects are completed just-in- time and within budget. EPMO methodology provides standard guided methods with guidelines that ensure that projects are conducted using the principles laid down in a well-managed way.

EPMO methodology is the only methodology that accepts that the only correct approach to an effective project management is "good planning and efficient controls implemented", through any good and well-structured organization.

The EPMO methodology is somehow very flexible and gives room to incorporating changing needs of products and well as those of the clients and also forecasting, predicting changes within the organisation based on production.

EPMO ingredient is the successful involvement of all its stakeholders and costumers in its entire project-lifecycle. The approach to its open-ended helps to add success while also applying and using its organizational methodologies and tools and techniques in achieving better results.

EPMO as the Gap Needs for EU28 Energy and Electricity production efficiency

The figure below, explains the production level and efficiency of energy and electricity production in the EU28. Looking at the figure, 0 % to 75% of energy and electricity production is technically planned (Engineering and Technology) and executed with a proper management methodology included. Although it hard for any company to achieve a hundred percent production or management level, it is considered that the missing gap for an efficient production that will help me EU28 production efficiency by 2030, is the Gap call EPMO Gap. EPMO is the organisation innovation of every company, Hobbs, B., Aubry, M., & Thuillier, D (2008)

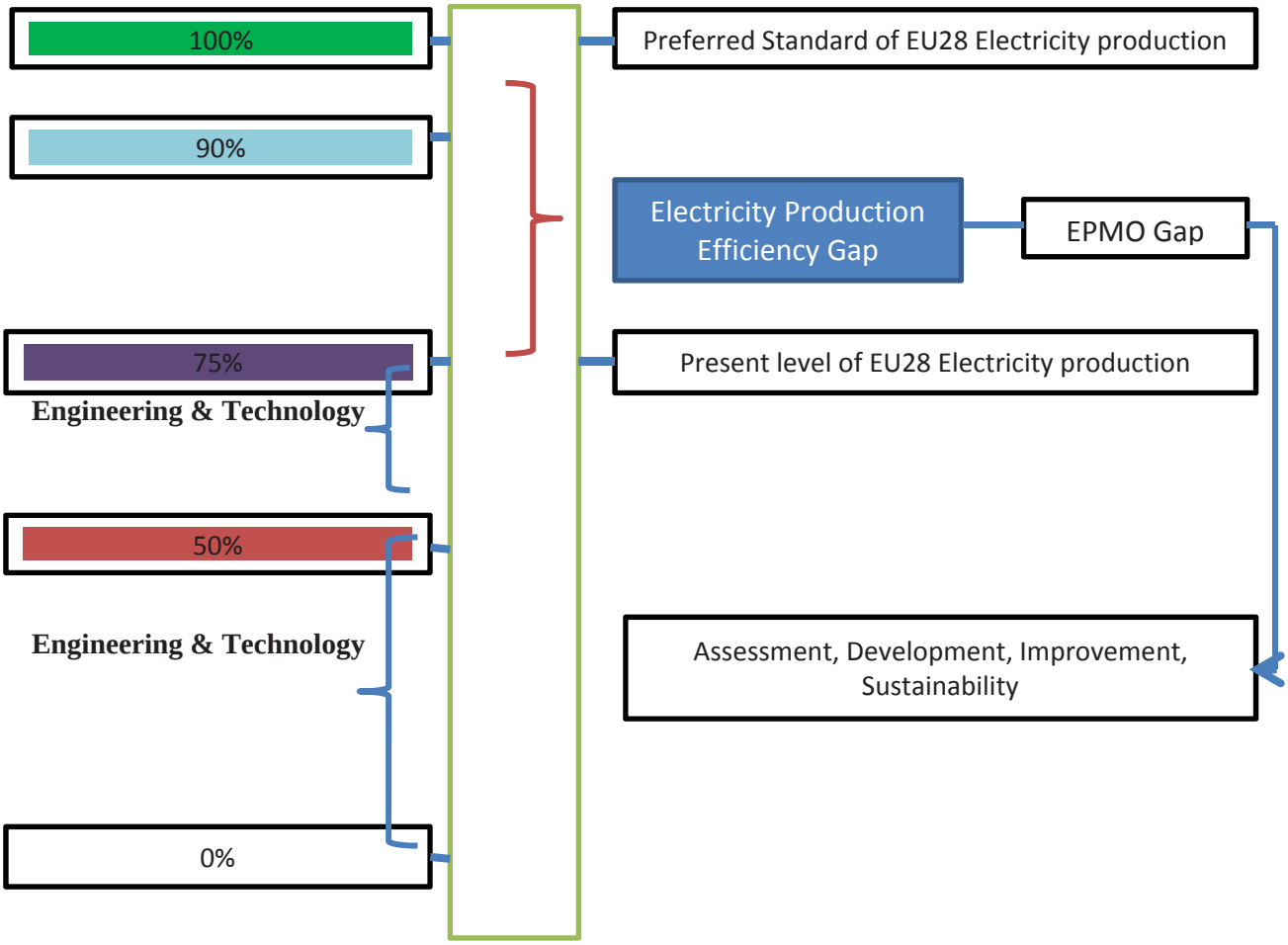

Figure 2: "Electricity Production Efficiency Gap (EPEG)"

A. **Assessment**

- Identification of different types of projects and programmes for Electricity and energy production
- Identification of inputs (Project Management Standards)
- Identification of constraints within the company, e.g. EU28 Energy policies on energy and electricity (Competitive policies, and EU28 Directives on energy and electricity production)
- The assessment of the Economics of European Integration and Regional Development Policy
- Identification and formulation of sustainability project management indicators
- Identification of ROI constrains

B. **Development**

- Development and proper documentation of sub embedded methodologies. E.G. European Foundation of Quality Management approach (EFQM) within the EPMO methodology
- Deriving output from inputs of project management standard: Base on the inputs, EPMO will help the company meets the objectives it was created for, through the proper mentoring of areas like:

1. Risk Assessment and Management
2. Governance Management
3. Cost and Portfolio Management
4. Lean Management
5. Value Management
6. Team Development
7. Change Management
8. Stakeholders Management
9. Development of Request for Proposal (RFP)
10. Supplies/Vendor Management
11. Training Need Analysis Evaluation

In the process of the developing the above by the EPMO; it has to also develop sub methodologies for each of the above mention management areas. Of these, the first three mentioned above, ***Risk Management, Strong Governance Management and Portfolio Management*** are the main standard that any Energy/Electricity production company should work on in order to achieve a higher degree of production efficiency. Therefore each EPMO has to develop the three sub methodologies as listed below

- Risk Management Methodology
- Governance Management Methodology
- Portfolio Management Methodology

C. Improvement

In building project management professionalism within the Electricity and energy producing companies, the EPMO staff will be train and guided as they learn and adopt best Project management practices in their projects. As seen in the figure below, the EPMO helps in providing a regular update, and from its improvement cycle, monthly status of Return-On-Investment (ROI) to yearly (annual) reporting of organisational activities on progress of production can be determined.

The figure below is an example of an improvement cycle any energy/electricity company can shape to help in its improvement process. This process examines both the Engineering Technology and Management Methodology and subs being use to improve and achieve better production results that will benefit the enlarge EU28.

C. **Improvement**

Conduct continuous improvement

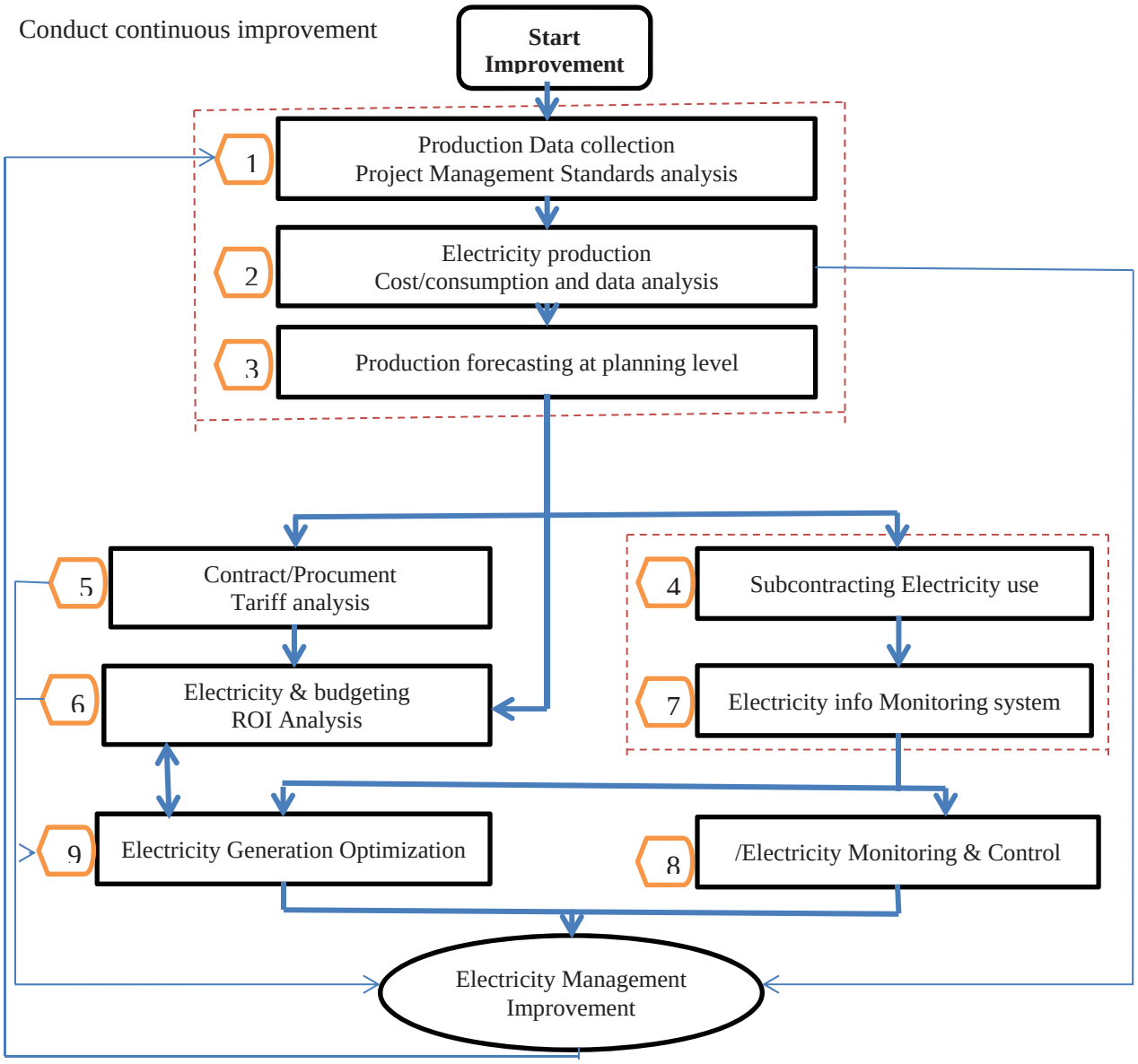

Figure 3: EPMO continues improvement cycle for electricity production management

EPMO also keeps tracks and help in monitoring key performance indicators. This process of monitoring for better results has to be repeated for each different project

4. Sustainability

According to Dyllick and Hockerts, 2002. “The balance between economic growth and social wellbeing has been around as a political and managerial challenge for over 150 years”

With the opinion of the stakeholders that these three goals, economic growth, social wellbeing and a wise use of environment, can be reached, without considering and effecting the other two, got widely accepted (Keating, 1993). With this widespread acceptance, sustainability became one of the most important challenges of our time facing organisations and their projects and of which companies in the energy and electricity are the most affected.

The concept of EPMO and PMO were created to helping organisations and companies to be able to better manage and strategized projects for sustainability. Investing in electricity projects especially designed to address environmental or societal needs, forward-thinking within the EPMO, leaders are embedding sustainability goals as a core project management processes. Whether EON, RWE, or EnBW Energie Baden-Württemberg Company is creating a new product; sustainability ranks as a top priority during planning and ensuring its presence throughout the project life cycle. ***(On how EPMO can support sustainability in project, please refer to my last conference papers of 2015, or you request a copy from me)*** This EPMO supporting sustainability is well applied in energy/electricity projects.

Development of Energy and Electricity Sustainability strategies in the three most important sectors; (Economic, Social and Environmental) as in the figure below

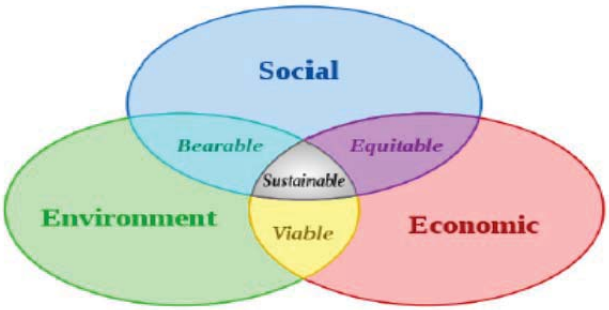

Figure 4: EPMO Electricity production sustainability management strategy ((source: Dyllick and Hockerts (2002),

The three concepts or pillars of project management sustainability if well developed by this methodology will help bring about electricity production efficiency within the EU28 as can be partitioned by the EPMO as below:

Economic Sustainability	Social Sustainability	Environmental Sustainability
• Business Agility	• Ethical behaviour	• Resources and materials
• Return-on-investment	• Society	• Waste Management
	• Labour	• Transport
	• Human Right	• Energy usages (Emission of CO2)

Table 3: EPMO areas of sustainability

In conclusion therefore, if a proper EPMO is implemented for any given energy/electricity Production Company, big or small,

- EPMO will serves as the main centre point of contact and control of all its strategic and enterprise engagement.
- The EPMO continually will be defining, establishing and continues facilitating major key processes meant for the enterprise
- With the EPMO application, the will be a balance organisational scope witness within the organisation
- The governance management will be enabling rapid communication, policy and decision making
- EPMO will be successfully institutionalising best business practises and ROI

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Influence of Organization Strengths on Project Management Competencies and Project Success

[1]Rao Aamir Khan, [2]Samman Ayyaz

[1]rao_aamir@comsats.edu.pk, [2]sammanzehra20@gmail.com
[1]Assistant Professor, [2]Researcher
COMSATS Institute of Information Technology
Park Road Chak Shahzad, 44000, Islamabad, Pakistan

Keywords: Project Management Competencies, Project Success

Abstract

The projects are important element of construction business. There are different types of construction projects and they may differ in terms of their complexity and size. There is a high competition in the business world particularly in the construction industry. If the construction companies want to achieve the success they must focus on the organization strengths and the project management competencies. The economic growth of a nation can be measured by the development of physical infrastructure like bridges, buildings dams, roads and parks etc. Construction project manager and team members struggle a lot to produce successful projects. Project management competencies act like a catalyst in the production of successful construction projects along with organization strengths. It would be worthwhile to find out those organization strengths that would lead the construction projects towards success. This research aims to examine the major organization strength factors, important project management competencies and the criteria for project success and their interrelationship. This research identifies a list of organization strengths for construction organization in Pakistan especially in cities of Rawalpindi and Islamabad. Based on the literature review, this research identified 45 organization strengths under three sub groups. Within the context of this research; interdependencies between construction organization's strength were investigated from a resource based perspective which would be helpful for the construction organization.

A questionnaire was designed to seek the perceptions of the respondents. The respondent were asked to rate the answer on a scale of 1–7, where 1 represents ''strongly disagree" and 7 ''strongly agree". The questionnaire was administered from

20 construction companies established in Rawalpindi and Islamabad. The target construction companies were all members of the Construction Association of Pakistan (CAP). The data was collected from the individuals of project management office (PMO) of construction organizations. Through these interviews it was examined that what is the importance of existing success factors in the construction projects of Rawalpindi and Islamabad. Five of the interviews were conducted from the individuals of project management office. From the interview participants relevant questions were asked in order to find out what they do think or feel about organization strength, project management competencies and their effect on project success. highly rated success factors and success criteria were short listed. The resutls were incorportated in the updated questionnaire and survey was conducted among the Project Management Office (PMO) individuals. In the survey 20 organizations participated, 150 questionnaires were distributed after taking consent from the PMO individuals of these construction organizations. 103 questionnaires were returned out of which 6 questionnaires contained missing values. The response rate was 64.6%. The results are compiled from 97 completely filled questionnaires.

The data obtained through construction organization were analyzed using structural equation modeling (SEM). The results of the survey verified the proposed study hypotheses. All identified organization strength indicators are found to be important and significant. On the other hand they are not properly implemented by the most of the construction organizations. The findings highlight importnace of particular organisation strengths that leads to building project management competnecies and eventually attaining project succes. These organization strength are of great significance both to researchers and industry practitioners.

PORTFOLIO MANAGEMENT OF MEDICAL INSTITUTIONS

Elena Danchenko

elen_danchenko@rambler.ru
doctor of technical Sciences, associate Professor, head. the Department of business administration and project management
University of Economics and law "KROK"
Ukraine, Kiev, St. Camp 30-32

Vladlen Lepsky

cherkassymsek@ukr.net.
Candidate of medical Sciences, honored doctor of Ukraine, academician of the Ukrainian Academy of Sciences, chief physician — chief expert KZ "COZ ITU CHOR", Cherkassy

Keywords: portfolio of medical projects, project-oriented medical organization.

Abstract: The analysis of medical institutions management processes. It has been shown that it is a design-oriented.
Revealed typical group processes that correspond to the main medical facility projects: projects of medical services, project support and research projects. In this case, the use of portfolio management methods will be most effective.

1. Introduction

The search for effective methods and tools for the management of organizations is based on the definition of the inner nature of their processes. In general terms, the control methods can be divided into operational and design. If your organization is dominated by the same type of constantly repeating processes, then it should prevail operational management principles. If the organization there are a variety of processes, consistent with the principles of urgency and uniqueness of the design methods and approaches in management may be used for such an organization. Such organizations may be project-oriented focus. Their sustainable development can be based on an evolutionary approach [1]. Medical institutions that provide medical care to the population, carried out a complex of measures, which has signs of uniqueness and urgency [2]. This means that they have a major project properties. Therefore, it is the use of one of the project management methods effective for them - portfolio management [3].

2. Analysis of the processes of medical institution

The search for effective methods of management of medical institutions should be based on an analysis of the processes of their work. Note that in this study are considered medical facilities that provide primary or secondary care of all forms of ownership. In Ukraine, such institutions include: emergency station, municipal outpatient departments of various specializations (dental, children's, women's clinics, etc.), district and regional hospitals of various specialization, research and other medical centers. [4] Enlargement can distinguish groups such processes.
1. The processes associated with the provision of medical services, depending on the profile of the institution.
2. The processes associated with the logistics of medical services.
3. Processes related research, training of medical staff, participation in various projects and Grand.
Most of the processes of the first and third groups have the main features of projects - is limited in time and uniqueness of the product obtained as a result of the successful implementation of processes. Therefore, the activities of medical institutions, we can highlight the projects of medical services and medical research projects.
The second group of processes is divided into daily, routine maintenance of the medical establishment and development processes. daily maintenance process does not have the properties of urgency and unique and can be attributed to the operating activities of the institution. The processes of development, which include the development of the strategy, the purchase of new medical and auxiliary equipment,

design and development of new medical services, have signs of urgency and uniqueness, and therefore can be recovered in the software projects. Thus, the analysis of the vital processes of the medical institutions showed that the combination of these processes can be positioned as an organization projects. These projects are diverse, serve different purposes, but at the same time dependent on the provision of health care projects.

Therefore, for effective management of the totality of the above projects should use the tools of formation and project portfolio management. [5] At the same time portfolio management will take over the health management institution as a project-oriented organization (VET). To ensure the effectiveness of such control is necessary to coordinate the goals and objectives of the strategic management of organizations at the stage of its creation with the objectives of the project portfolio. [6]

3. Project Portfolio medical institution

Availability of medical services projects has positioned health care institutions as a project-oriented organization, which operates through its projects. Medical industry sets some features of medical VET compared to other project-oriented organizations, such as the construction industry. These features include: 1. Implementation of the next project of medical services does not require additional investment funds. The cost required for the purchase of consumable products, wages of doctors and staff, medical equipment maintenance. 2. Formation of a portfolio of health projects is determined by the main criterion - to ensure the highest possible quality of medical services. 3. Gender sensitivity of medical portfolios. [7]

It should be noted that in this case the portfolio of health projects is a tool to achieve the strategic objectives of a project-oriented organization. This means that the success of each project determines the success of the portfolio and further - the attainability of strategic healthcare facility objectives [8]. In this case, the two-level management principles should be applied: planning and strategic goals at the top level and operational management of the project on the ground. [9]

Combining medical portfolio of diverse projects will require the development of effective control methods, taking into account the medical specifics. The presence in the medical portfolio of all the above projects: ensuring projects, project and delivery of health services research projects, depending on the size and specific medical institution. The main medical portfolio are projects to provide medical services. They are organized to ensure the projects for them and on the basis of these research projects are carried out.

The presence of the medical portfolio of diverse projects brings additional risks to the entire portfolio as a whole [10].

4. Results and Conclusion

It is shown that modern medical facility is a project-oriented organization. Strategic management of such companies through a portfolio of projects.

As a result, health care facilities management process analysis revealed the typical process groups, which correspond to the projects. These projects provide medical services to ensure projects and research projects. In this case, the use of portfolio management methods will be most effective.

The proposed classification of health facilities will be used when planning the result (value) of the medical portfolio.

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The action research methodology applied for analyzing how to integrate sustainability into Project Management.

Leticia Fuentes-Ardeo, Jose Ramon Otegi-Olaso, Maria E. Aguilar-Fernandez

Lfuentes005@ikasle.ehu.eus
PhD Student
University of the Basque Country (UPV/EHU)
Alameda Urquijo, S/N, 48013, Bilbao

Keywords: Project management, research methodology, action research, knowledge management, sustainability.

Abstract:

The research of Project Management has not arrived a high maturity stage. Considering this fact, it has been identify a gap related to which methodology is the more appropriate to use so as to perform research in Project Management. The aim of this paper is to analyse how the action research methodology can be used in order to process a research in Project Management field.

To develop this study, it has been used as a guide, the methodology followed by Chivonne [1]; where a project manager group has been studied to analyse how the knowledge acquisition and exchange is accomplished. For this paper, the focus group is formed by five researchers that are studying how sustainability can be integrated in the project management field. There have been done four action research cycles (Plan, Act&Observe and Reflect); considering the knowledge transition modes proposed by Nonaka&Takeuchi [2].

In the first cycle it was been paid attention to the knowledge acquisition mode; the second cycle was focused over the knowledge extraction; the third cycle to knowledge exchange and finally the fourth cycle to the analysis of the knowledge externalisation. Besides, the output of each of the cycles has been validated with an external expert group.

With this experiment it has get to a better understanding of the action research methodology; it has been identify the reference authors related to the topics; there has been an acquisition of new skills for paper analysis and there has been an improvement related to communication skills.

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The Construction of Research Questions in Sustainable Project Management

Briongos-Vázquez, Naiara;
Otegi-Olaso, José Ramón; Martinez-León, Laura

bv.naiara@hotmail.com
University of the Basque Country,
Faculty of Engineering
European Master in Project Management
Urkixo Zumarkalea, S/N, 48013, Bilbao, Vizcaya, Spain

***Keywords*:** Research question, Gap Spotting, Problematization

Abstract: Nowadays, sustainability is one of the most important challenges that the companies face. Sustainability activities are demanded by customers, non governamental organizations and legislation and this has a great influence on the product design and the processes of construction or development of projects.This is the main reason that makes that sustainability is finding its own space in project management methodologies and practices. The aims and purposes of this study are about improving learning for improving practice in order to develop new ideas for a sustainable project management. It is necessary to look for opportunities for theoretical contributions in qualitative studies. The research questions are one of the methodological steps that are necessary to start a research. Choosing a research question is fundamental and it is the base for the construction of a new theoretical framework, this way it is exposed what is looking for. The research questions are the origin of the research hypothesis and they also drive data collection for the study. It has been necessary to review what has been studied about the research questions to date in order to further the knowledge that has been previously gathered about this issue.And for this reason, the methodology approaches has been built upon the work of Cameron et al. (2015), Otegi-Olaso et al. (2015), Muller (2011), and overall, Locke ad Golden-Biddle (1997), Sandberg and Alvesson (2011) and Hällgren (2011). Thirty-five papers, related to methodologies, project management, sustainability, environment, lean practices or green projects, have been reviewed. The argumentative practice is carried out following Hällgreen model (2011). So basic modes of research question construction are used to identify how the authors have created opportunities for theoretical contributions in the sustainability field. The results show the dominance of several modes of research questions and this issue that should be taking into account for the future.

1. Introduction

Nowadays, sustainability is one of the most important and interesting challenges. Because of this, companies are introducing new ideas related to sustainability in their actions. This is the main reason that makes that sustainability is finding its own space in project management methodologies and practices.The aims and purposes of the construction of research questions in sustainable project management are about improving learning for improving practice in order to develop new ideas for a sustainable project management.The adequately formulated research questions may develop new ideas from old ideas. And although the research questions are very important in scholarly work, there are not a lot of references about this subject. Textbooks about research methodology do “not provide more specific directions on ways to formulate innovative research questions by scrutinizing existing literature in a particular research area”

2. Theoretical Background about Research Questions

The interest for research questions is not anything new. In 1997, Locke and Golden-Biddle reviewed 82 papers looking for the origin of the theoretical contributions. They divided these papers into two main categories: Inter-textual coherence refers to coherence or incoherence of previous works. And problematization that is based on deficiencies in present theories that have to be solved.

Taking into account Locke and Golden-Biddle´s study, in 2012, Sandberg and Alvesson reviewed 52 papers and they developed a new theory respect to Locke and Golden-Biddle´s theory. They identify 3

main modes: Gap spotting: Divided into three main categories: Confusion spotting that looks for contradictions. Application spotting that comes in response to a new vision, perspective or theory. Neglect spotting: that treats about an area that needs attention and analysis and also divides into: Overlooked area when studied area is developed but certain point of view needs to be studied. Under-researched area when there are still uncharted areas. And Lack of empirical support when areas are studied but that theoretical background has not been implemented. On the other hand they identify problematization divided in 4 categories: Critical confrontation that doubt about the assumptions of certain areas. New idea that shows original questions, despite of being based on a existing defect. Quasi-problematization that gives alternatives to problematizaton. And Problematization that are constructed developing logic-breaking arguments.

Hällgren (2012) adds two additional modes to 5 spotting modes of Alvesson and Sandberg. Empirical need or example, identifies an empirical need rather than a theoretical contribution and is oriented to practitioners. And research overview that tries to understand the past and/or future research trends and for it, a revision of the literature is carried over.

3. Methodology

The methodology approaches of Martínez-León (2016) and Briongos-Vázquez (2016) was built upon the work of Cameron et al. (2015), Hallgren (2012), Otegi-Olaso et al. (2015), and Muller (2011).

According to the Muller analysis (Table I, p:93) , the Ontology position is Objetivism, the Espistemology is Post-Positivism and the Methodology is a Content analysis.

The sample frame technique is a non-probabilistic, judgment criteria purposed by Malhotra (2008, p 340). The next sample frames were chosen: A set compounded by the four PM Journals: IJPM, JPM, IJMPB, IJPOM;A set compounded by journals in allied areas; A set compounded by the Sustainability and Environmental JCR journals.

It was necessary to conduct a bibliometric research using SCOPUS and WOS (Otegi et al. 2015), using the following keywords: “Project management”, “methodology”, “sustain”, “environ”, “OR projects”, “lean”, “sustainable” and “green project”.

So, to summarize, this paper is based on: 5 papers about methodology and project management , 25 papers about project management, sustainability, project and environment and 5 papers about lean, sustainability, green and/ or project

According to developed praxis for Locke and Golden-Biddle (1997), Sandberg and Alvesson (2011) and Hällgren (2012), the entire paper is read argument-by-argument to identify key factors for the construction of research questions. The argumentative practice is carried out and using a deductive analysis and inductive thinking when the framework is difficult to fit. Illustration 6 shows the development of the research.

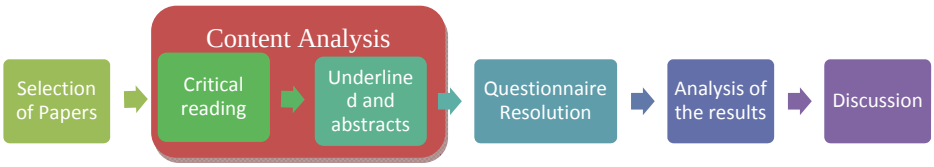

Illustration 1: Development of Paper (Fig. by Briongos-Vázquez)

4. Data Collection

Data have been collected through a questionnaire with several general questions and other specific questions to know the type of research question that the researchers have used for the construction of their studies. Some of these general questions are related to the research questions in each paper or the application of the research, and the others are related to suggestions and thoughts about each article. Thanks to the data of this table, it is possible to develop a qualitative analysis. A Quantitative analysis

will be developed with the data of the next table. This table analyse every paper, using the different questions to obtain results. The questionnaire has been designed so that each question is related to a way or construction of research question.

5. Discussion

The main purpose is to analyse the construction of research questions. Thirty five articles were reviewed taking into account Hällgren method (2012). A scheme was created to facilitate the understanding and differentiation of the modes and specific constructions. The following table summarizes the concepts of gap spotting modes and types of construction of research questions.

The review reveals that there is a clear predominance of gap-spotting pattern against assumption-challenging modes.

5.1. Modes of Research Questions Analysis

Based on the table of results, previously exposed, the following analysis tables are developed. It is possible to appreciate how many different modes appear in the 35 chosen papers and the percentages.

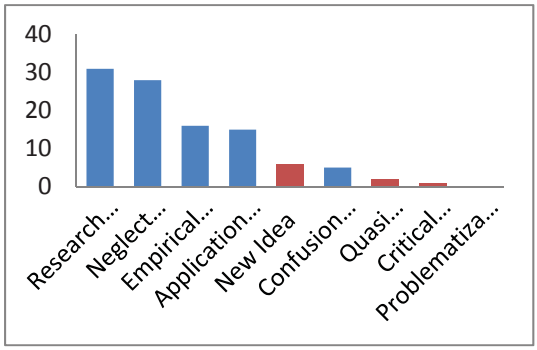

Illustration 2: Modes in Papers (Fig. by Briongos-Vázquez)

Research overview mode and neglect spotting mode appear much more commonly than the rest of modes. The presence of gap spotting modes is well above problematization modes (but confusion spotting). In contrast problematization mode is not present in any paper and critical confrontation mode and quasy-probletización are not almost presented in the 35 papers.

In the questionnaire, there are different questions for the same mode. This happens with empirical need or example mode, new idea mode and problematization mode.

- Empirical need or example analysis is oriented to practitioners and contributes to the development theoretical, but it does not contribute to the practical development. In 24 of 35 papers contributes to the development theoretical, not practical and 25 of 35 are oriented to practitioners.
- New idea mode is characterized by originality although it is based in a failure of existing literature. Approximately 71% of chosen papers present new and original proposals in their fields of study, and approximately 23% present new theories for their respective fields.
- Although none of the papers present the problematization mode, 1 of them denies part of the present knowledge and 9 of them doubt about existing literature.

5.2. Type of Construction of Research Questions Analysis

It is possible stablish a relation between modes and Specific Constructions of Research Questions. And thanks to it, the following analysis table is developed.

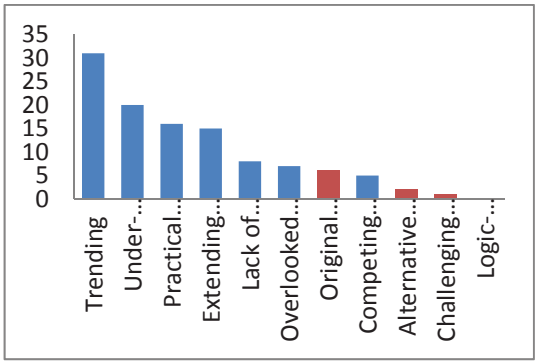

Illustration 3: Specific Construction in Papers (by Briongos-Vázquez)

Breaking down the different modes into their types of constructing RQ show the types of construction related to gap spotting modes are much more usual than types of construction related to problematization modes. This perfectly matches modes of RQ analysis.

5.3. General Questions Analysis

The research questions are the first step in a research, so it is interesting to know if the researchers show clearly what they are searching for or they do not do it.

There is not a great difference but the research questions appear explicitly in more papers.

It also interesting to know if the results or suggestions found in papers can be apply to other fields of action.54% of the papers obtain results or proposals that can be applied in other fields, 11% of them cannot be applied to another field and the rest (34%) is difficult to know due to limitations of the study.

6. Conclusion

It is seen a great dominance of gap spotting against problematization. This show that gaps in literature are identified and literature can be extended but it also shows it is a deficiency with the regard of the production of new assumptions. The choice of gap spotting in RQ construction can lead to the sacrifice of innovation but the choice of problematization can lead to a lack of credibility.

The selected papers reflect the status of sustainable project management and provide a sample to research. This field is relatively new so it is normal obtained results. The most of the papers are constructed according to research overview mode and neglect spotting. This is because research overview mode checks the literature looking for a guideline to understand past and/or future research evolutions, On the other hand, neglect spotting try to identify a gap in the literature because there is an uncharted area and require academic attention and analysis. These 2 predominant modes match a new field like sustainable project management, which need to develop new hypothesis. The prevalence of research overview evidence a theoretically oriented field of research and the prevalence of neglect spotting and particularly of under-researched area show a lack of focus in the present literature.

The results suggest that it is possible that great potential can be generated and should be empirically proved. But it is necessary to develop new proposals and put into practice the theoretical research.According to the results, challenging assumptions and achieve logic-breaking arguments should be a priority for researchers

6.1. Suggestions for Research

Future Research could attempt to examine the influence of some different modes and types of construction of research questions on the others modes and types of construction. In addition, this study has not classified the papers according to their prevalent mode or type of construction, so this can be developed in future researches. It also interesting for future research, the analysis of the research questions attending to the publication where the study is showed.

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MIXED METHODS USE IN SUSTAINABLE PROJECT MANAGEMET RESEARCH

Martínez-León, Laura
Otegi-Olaso, Jose R.; Briongos-Vázquez, Naiara

University of the Basque Country
Faculty of Engineering
European Master in Project Management
Bilbao, Bizkaia, Spain
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Keywords: Project Management, Mixed Methods, Research Methods, Sustainability, Sustainable Development, Green

Abstract: Among the many ways that sustainable development has been defined, the most widespread and well-known definition is the one by the World Commission on Environment and Development (1987), 'forms of progress that meet the needs of the present without compromising the ability of future generations to meet their needs'. Although this definition was coined some decades ago, it takes some time for a mind shift in society. Nowadays, in a more demanding and committed society, one of the main challenges that companies are facing is sustainability. The mixed methods movement is also increasingly gaining popularity and utility in the project management research. Not only for triangulation as a validation strategy, but also to add more in-depth investigation and a broader perspective of the researched phenomenon (Cameron & Sankara 2013, p.398). Build upon the work of Cameron et al. published at the PMJ (2015) 'Mixed methods use in project management', and aligned with the main pillar of this research team, sustainability, the aim of this work is to evaluate the use of mixed methods by project management researchers in the field of sustainability. As would be expected, mixed method approach is used to address this aim.

1. Introduction

Silvius and Schipper (2014) studied the introduction of sustainability in project management. After a structured review of 164 publications, covering the time period 1993 - 2013, that join sustainability with project management, they identify a growing number of publications that relate sustainability to project management and the areas of impact of sustainability on project management.

The mixed methods movement is also increasingly gaining popularity and utility in the project management research. Many researchers have been using mixed methods research in the last decades. However, they refer to them by many different names, such as combined method, integrated method, multilevel, etc.

The aim of the study "Mixed Methods Use in Project Management Research" by Cameron et al. (2015) was twofold: (1) To examine the types of mixed methods approaches being used, and (2) To determine the quality of the reporting of mixed methods studies published in the field of project management.

According to Tashakori and Teddlie (2003), Cameron et al. (2015) made use of a multistrand conversion mixed model research design, with an overarching research question and separate qualitative and quantitative subquestions.

The purpose of this work is to evaluate the use of mixed methods by project management researchers in the field of sustainability and whether the use of mixed method research is being reported or not.

2. Methodology

The methodology approach of Martínez-León (2016) and Briongos-Vazquez (2016) was built upon the work of Cameron et al. (2015), Hallgren (2016), Otegi-Olaso et al. (2015), and Muller (2011).
The sample frame technique is a non-probabilistic, judgment criteria purposed by Malhotra (2008, p 340). The next sample frames were chosen:
A set compound by the four PM Journals: IJPM, JPM, IJMPB, IJPOM
A set compound by journals in allied areas (Kwak and Anbari).
A set compound by the Sustainability and Environmental JCR journals.
It was necessary to conduct a bibliometric research using SCOPUS and WOS (Otegi et al., 2015), using the following keywords:

1. "Project management" + methodology (for the 5 main papers)
2. "Project management" + sustain*
3. "Project management" OR projects + sustain*
4. "Project management" + environ*
5. "Project management" OR projects + environ*

The output of the first point was a set of 10 papers and 5 were selected after reading the abstract and introduction.
The output of the (2-5) points was a set of 51 papers and 25 were selected, after the analysis of the abstracts, and the introduction.
In the literature review for this study, five papers related with Lean and sustainability were selected. The selection was decided because Lean methods have the principle of focusing on customer value and waste reduction. This is closely aligned with the principal features of sustainability. The close relationship with sustainability concepts makes Lean philosophy a useful tool that can be used by project managers to achieve sustainability.
The Lean papers selection was conducted by identifying the "Lean", "sustainability", "green" and/or "project" words in the title, abstract and keywords. Papers published in peer-reviewed journals and proceedings from the year 2000 up to 2016 were selected. After carrying out a filtering process by reading the abstracts, these five articles were chosen for research contribution.
In order to simplify the work, 5 researchers work together, so that each of them have to review 7 papers (1 methodological paper (X1), 5 papers about project management, sustainability, project and environment (X2...X6) and 1 paper about lean, sustainability, green and/ or project (X7)).

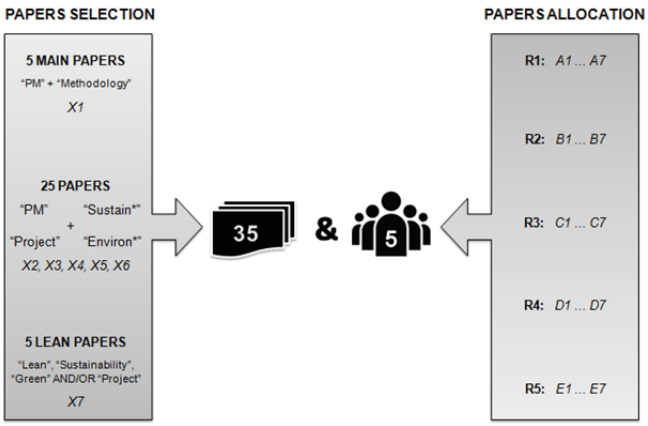

Fig. 1. Selection and allocation of the analyzed papers in this research.

Cameron et al. (2015) followed the Morse and Neihaus (2009) “dissection chart” to systematically examine and clarify the design of mixed methods in published articles. They suggest starting reading the entire article by first making notes, highlighting the aim of the study, examining the research questions that were asked, looking at the sample used for the components of the study, noting the methods, and examining the pacing of the data collection and interface points.

Accordingly, each of the 35 papers previously selected were analysed underlying and extracting notes from the text. During this data collection strand, and in order to avoid the impact of reviewer bias, workshops took place every week, in which every researcher pointed out their findings and solve other colleagues’ questions.

Once the articles were analysed and all the data from the studies was extracted, a specifically designed questionnaire for this paper was completed. This questionnaire summarized all the main information to answer the research questions established at the beginning of the research, which allows the researchers to develop the discussion, conclusions and limitations of this work.

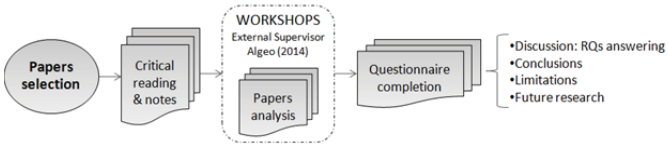

Fig. 2. Development of the paper

3. Research questions

According to Cameron et al. (2015), who took the approach of Teddlie and Tashakkori (2009) to achieve a deeper understanding, this research gives answer to the following questions:

- Quantitative sub-questions

What is the frequency of use on mixed methods research within sustainable project management research?

- Qualitative sub-questions

Is the priority and sequencing given to qualitative and quantitative data in mixed methods sustainable project management research being reported?

4. Data collection

The different deliveries resulted of the data collection of this research are collected in the annexes of this work.

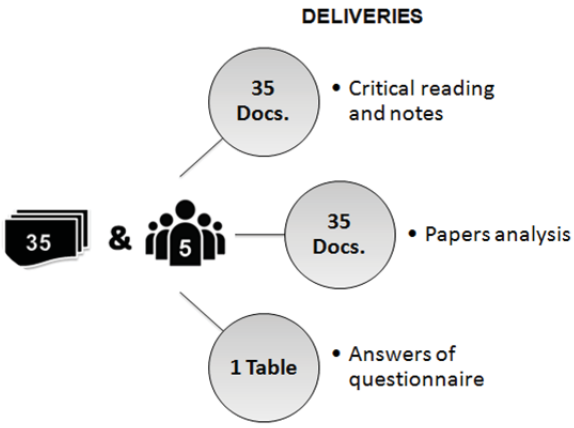

Fig. 3. Deliveries of data collection

The questionnaire was designed in order to gather all the relevant information to give answer to the research questions:

- Data collection: qualitative, quantitative or both?
- Data collection: are both, qualitative and quantitative data collected at the same time (concurrent)?
- Data collection: is any form of data collection building on the other (sequential)?
- Data collection: are any of the methods being emphasized? What method?
- Data analysis: qualitative, quantitative or both?
- Describe briefly the sequence of the methodology used? Is any method dominant?
- Do the authors mention / declare that they are using mixed methods (it can also be named as combined method, integrated method, multilevel...)?

5. Data analysis and results

In order to classify and quantify all the information gathered in the previous step, this information was codified using notation that has been developed in the mixed methods field.
Mixed methods notation provides shorthand labels and symbols that convey important aspects of mixed methods research, and it provides a way that mixed methods researchers can easily communicate their procedures. The notation followed in this research is adapted from Morse (1991), Tashakkori and Teddlie (1998), and Creswell and Plano Clark (2007).
Two papers (B6 and E6) were not considered for this study as there was no data collection because their conceptual nature.

6. Discussion

The following observations are based on the results of the questionnaire collected.

- Quantitative sub-questions

What is the frequency of use on mixed methods research within sustainable project management research?
Figure 4 displays the summary of the usage of mixed methods in the sustainable project management research.
According to the results, 17 papers out of the 32 make use of mixed methods. This is higher compared with what was found in the project management field (Cameron et al. 2015), were mixed methods represent approximately the 12% (25 papers out of a sample of 214).

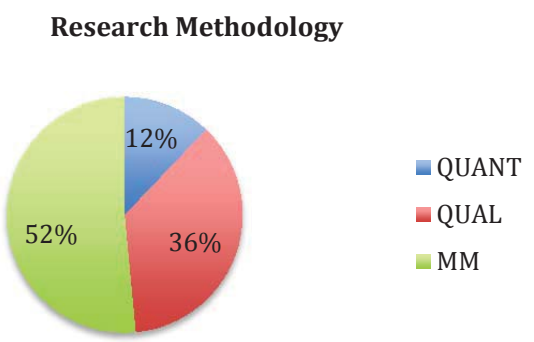

Fig. 4. Percentage of the research methodologies found in sampled papers

- Qualitative sub-questions

Is the priority and sequencing given to qualitative and quantitative data in mixed methods sustainable project management research being reported?

In all the cases analysed not, this factor greatly difficult the coding of the papers and due to the subjectivity associated can lead to information bias, which on the other hand the researchers of this paper tried to avoid by the workshop sessions.

7. Discussion

Looking at the findings of this research, it is becomes clear that the mixed methods use is the field of sustainable project management is gaining momentum. This result is aligned with the general observations from the study of Sankaran et al. (p. 101; 2015): "Our findings indicate that the use of mixed methods in project management research has increased marginally since 2014; however, it is not keeping pace with the use of mixed methods in other fields of management research."

Nevertheless, due to different reasons, that are not object of this study, the majority of the researchers do not explicitly report the use of the mixed methods, which difficult to identify them, and even when it is claimed, other terms are used instead of "mixed methods" in most of the cases.

It is also clear, that the priority and sequencing given to qualitative and quantitative data of the mixed methods used in sustainable project management research field is not being reported. This contributes to the subjectivity in the analysis of the priority of the methods used, a fact to take into account for a greater research about this topic in the future.

This study was limited in scope and the size of the sample (35 papers) due to time constraints, but it is a first approach towards a future research about the mixed methods use in the field of sustainable project management.

8. Acknowledgement

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Explorative Project Management for Innovative Projects

Carsten Wolff
carsten.wolff@fh-dortmund.de
Fachhochschule Dortmund
Emil-Figge-Straße 44
44227 Dortmund

Maria Zadnepryanets
mazad001@stud.fh-dortmund.de
Fachhochschule Dortmund
Emil-Figge-Straße 44
44227 Dortmund

Keywords: Project Management, Adaptive Project Management, NCTP model, PMBOK

Abstract: Proposal for the holistic approach to the management of the innovative projects is the main topic of this paper. The proposal - Explorative Project Management - is developed based on the experience in taking part in the Innovation Project at KU Leuven - Group T and additional literature review.

1. Introduction

Nowadays innovation is one of the key drivers of the business and organizations. Given that and the tendency of the companies to move towards the projectized organization structure, the topic of the project management in application to the projects, that contain element of innovation, attracts a lot of attention from the researchers.

Indeed, elaborated and mature Project Management methodologies, adapted to the needs of the different industries, are available for the managers. But often those methodologies are not efficient, when applied to the innovative projects. In addition to that the definition of the success in case of the innovative project is usually broader than traditional Project Management triangle approach. An alternative approach to management of the innovative projects - Explorative Project Management - will be proposed in this paper based on the experience gained during work on the student project (Innovative Project) and corresponding literature review.

Innovative Project was a part of the curriculum of the “Postgraduate Programme in Innovation and Entrepreneurship in Engineering” at KU Leuven - Group T. The goal of this Project was to present an innovative solution for the cargo ship on the Ecorace Challenge Competition. The project was completed in time, with lower budget than initially planned, but with deviations from original scope. Nevertheless the presented vessel was recognized during the Competition. Based on the lessons learned from this Project and on subsequent literature review the following extensions to the traditional Project Management approach are proposed:

- Analysis of each of the Work Packages using “Diamond Framework”, subsequent risk identification and application of the appropriate management style to management of the innovative project.
- Iterative approach for the project scope definition followed by schedule update and quantitative budget and risk analysis. The analysis of the lessons learned from the previous iteration is also an important part of each iteration.

First section of the article will provide a deeper view into the Innovative Project followed by the overview of the traditional Project Management tools, which were applied to lead it. Further will be presented the results of the literature review and resulting proposal for the Explorative Project Management approach based on the traditional Project Management Tools, "Diamond Framework" and passive Adaptive Project Management.

2. Innovative Project

In this article will be analyzed application of the traditional Project Management tools, techniques and principles to the Innovation Project held as a part of the "Postgraduate Programme in Innovation and Entrepreneurship in Engineering" taught in KU Leuven - Campus Group T in the 2015-2016 academic year.

The goal of the Innovation Project was to construct a cargo vessel and present it at the Ecorace Challenge Competition held on 14th and 15th of May, 2016 in Brugge, Belgium. Duration of the project was 2 academic semesters. The involved Project Team - KU Leuven EcoChallenge Team - was an international Team that consists of 6 Master Students from KU Leuven Campus Group T, 2 Graduate Students of UCLL and a Master Student from FH Dortmund. The scope of the project included not only engineering aspect - development and implementation of innovative solutions in areas of autonomous sailing, improvement of the vessel's maneuvering characteristics and efficiency through the advanced bow propulsion system and innovative drive train solution, but also development of the business plan - proving feasibility of the proposed solution in the real life. The main goal of Project Management application in this case was to ensure the Project success and to help the KU Leuven EcoChallenge Team win in the Ecorace Challenge Competition. [1], [2]

Below can be found the aspects that strongly influenced the applied Project Management approaches and Project success:

<u>Innovativeness</u>

- Scope was undefined at the beginning of the project and changed greatly, along with time and budget during the Research & Design phase of the project.
- Iterative approach to the project planning was applied.

<u>Engineering</u>

- Tangible product was an outcome of the project, which implied limitation on usage of the Agile Project Management methodologies.

<u>Student</u>

- Project Team Members had no or little experience in the ship-building area.
- Project Team Members had little experience in the task duration estimation.
- The project schedule was influenced greatly by the University study schedule.

The vessel was presented during the Ecorace Challenge Competition as planned; the construction costed less, than it was originally estimated, but not all of the planned functionality was presented. Therefore, from the formal point of view, the Innovative Project failed. Nevertheless the vessel was recognized as the "Most Innovative Vessel" and "All Round Winner" in the Cargo category. [1]

Further will be discussed the tools and techniques used to support this project from the Project Management side and further proposal based on the received experience.

3. Applied Project Management Approach

At the first phase of the project additional research was performed on the possibility to apply the Agile methodologies to the management of the discussed Innovative Project. Unfortunately these methodologies were recognized as not applicable due to the nature of the project and waterfall approach to project work planning was chosen. Nevertheless iterative approach to the scope and budget estimation and project schedule development was used. To support Innovative Project PMBOK® version 5 methodology was applied.

Below will be provided an overview of how the tools described in PMBOK® Guide version 5 were applied to the management of Innovative Project, broken down by the phases of the Project.

Table 1. PMBOK® Guide version 5 Project Management tools application to Innovative Project.

Project phases	**Initiating**	**Monitoring and Controlling**		
		Planning	**Execution (Research&Design, Implementation, Testing)**	**Closing (Delivery, Closing)**
Tools & Techniques	· Ground rules · Project scope statement · WBS		· Project (status) reports · Change requests	· Project plan · Budget
	· Activity list · Milestone List · Project schedule · Communication plan · Project plan · Budget · Lessons learned · Risk Register			

Even though PMBOK® Guide version 5 is one of the most elaborated Project Management methodologies, for the Innovative Project it proved to be not optimal as it doesn't explicitly outline iterative approach to the planning and does not recognize the difference in influence on the project success of the different parts of the project. Further will be provided a literature review that aims to find solution for these challenges.

4. Literature review

Further will be presented the research results focused on finding on the alternative Project Management approaches and best practices to the management of the projects with the strong focus on innovation.

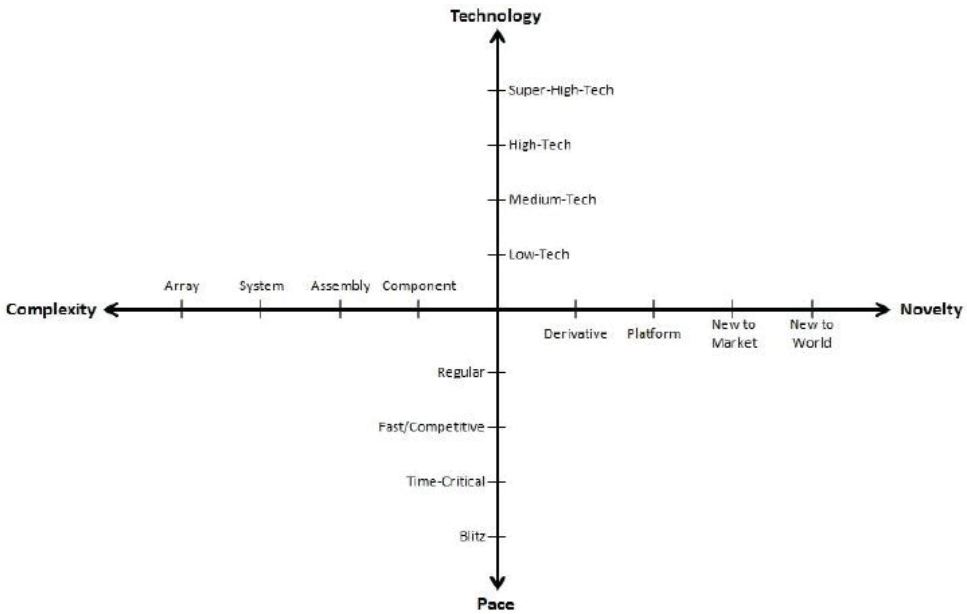
"Diamond Framework" for innovative projects

The approach presented in the work of Shenhar et. al. proposes not only classification for the degree of innovation in the project - “Diamond Framework” - but also gives guidance on the risk identification and Project Management approach, that proved to be successful in application to each of the kinds of the projects.

The “Diamond Framework” (also called the NTCP model) uses the following dimensions “to analyze projects, so that everyone involved can gain a better understanding of what needs to be done.” [7]

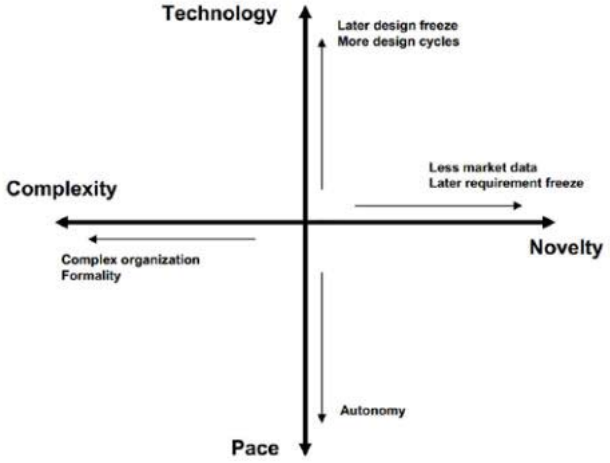
1. “Novelty” dimension identifies, how intensely new the crucial aspects of the projects are. The projects are categorized as “derivative product” - revised offering of an existing successful product, “platform novelty” - new version of the existing product and “breakthrough products” that don’t yet exist on the market.
2. “Technology” reflects the maturity of the technology used to develop a product. “As the level of technical complexity increases, so does the risk of failure and the likelihood that efficiency will fall.” [7] The following levels of the technological novelty are distinguished - “low-tech” (have almost no technological risk), “medium-tech”, “high-tech” and “super-high-tech”.
3. “Complexity” reflects the sophistication in interaction between the project and product parts, which requires more formality in project management. The following categories of complexity are distinguished:
    a. “Assembly” – the lowest degree of complexity; usually related with materials, components, subsystems and actual process of assembly.
    b. “System” – usually refers to the manufacturing more complex products, like computers.
    c. “Array” – this type of projects require coordination among multiple systems and are usually hugely complex.
4. “Pace” – This dimension reflects the urgency of the innovation, and its levels are “regular”, “fast/competitive”, “time-critical”, and “blitz”. [7]

Figure 1. Traditional project management process versus active and passive adaptive management processes. [7]



Based on this analysis Shenhar et. al propose specific management approaches to management of different types of the project, which are demonstrated on Figure 2.

Figure 2. “Diamond Framework” dimensions influence on the planning/managing of a project [7]



Orhof et. al in their work made one step further beyond and investigated, how based on the “Diamond Framework” the vitality and challenge incorporated in each of the project parts are incorporated, and, how the “Diamond Framework” assessment can be built into the standard PMBOK® approach to project planning. Further will be provided an overview of both proposals.

Traditional Project Management methods, PMBOK® for example, provide guidance on how to break down the project into smaller parts (Work Breakdown Structure), but after that they recommend to use “one size fit all” approach for management of each of the project parts. But “not all the project components are equally important to its success. Failure to successfully complete certain components in time will only result in minor consequences to the final product, rendering their overall impact on the final product marginal. Some components are likely to be more difficult or challenging to complete than others due to different levels of uncertainty, technology, or lack of resources.” [4] Therefore the authors suggest to differentiate each project component by assigning to it two attributes: challenge and vitality.

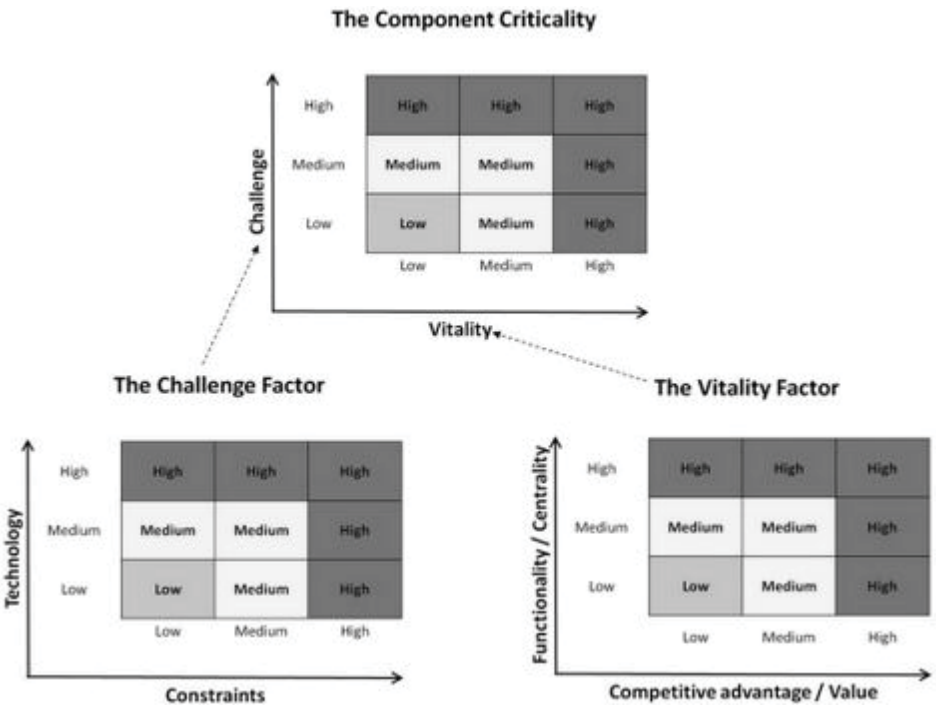
- The challenge attribute refers to the difficulty to complete the specific component and therefore overall project. Challenge usually depends not only on the technological aspect of the work (which is defined similarly in this case, as in the “Diamond Framework”), but also on limitations that are imposed on a specific component, e.g., due to legal regulations or scarcity of resources. It is recommended to differentiate components with low, medium and high level of challenge.
- The vitality attribute refers to the importance of the component to the success of the product or the project. This attribute has also two dimensions: centrality and competitive advantage. The first one, centrality reflects “the importance of a component to achieving functionality of the end product that the project is expected to deliver.” [4] The competitive advantage component refers to “the contribution of the component to the value that the customer attributes to the product having this component.” [4] As in previous case, each of the components can be assessed using low, medium and high level scale.

“Together, these two attributes define the level of difficulty-importance of each component, providing for the identification of the more critical and the less critical components.“ [4] This

classification also allows to recognize and act upon the fact that different project components "require different managerial styles, depending on their challenge and vitality... A component that poses a high level of challenge (difficulty) to the project, and/or considerable vitality (importance) to the success of the product, should be managed in a different, more careful way from a component that poses no real challenge and is not vital to the product success." [4]

The example below shows how the described components - challenge and vitality - can be categorized using a three-by-three matrix. The combined challenge-vitality value is the criticality of the component to the overall success of the project-product. Also we can state that "a critical subproject as a part of the project that is expected to deliver a critical component. A critical subproject poses an exceptional risk to the success of the entire project. Absence or partial availability of that component jeopardizes the project success. "

Figure 3. Criticality factor assessment. [4]



Another work of Orhof et. al. provides broader view on the definition of project success based on the survey of 127 project managers and recommends approach to incorporation of the analysis based on the "Diamond Framework" in the regular PMBOK® planning process.

The reason for the survey of project manager showed that the traditional view on the project success doesn't reflect the actual value of the project result. For example, focus only on triple constraints can lead to the delivery of the unuseful for end customers product. Based on the research Ohrof et. al. identified the following factors that contribute to the project success:

- "Project efficiency defines whether the project was finished on time and within the specified budget.
- Impact on the customer relates to the influence on customer and the end user of the product resulting from execution of the project...

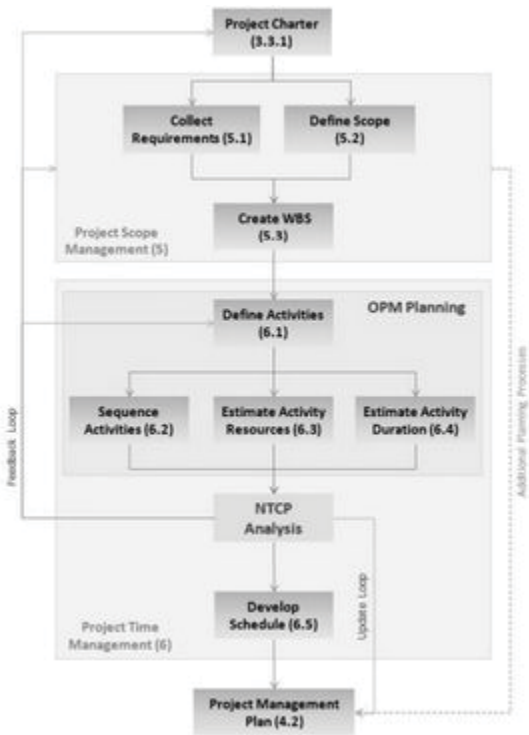
- Business and direct success addresses the direct impact the project has on the organization (increased business, profit, efficiency, etc.).
- Preparing for the future relates to the project's contribution to the organization's readiness for future opportunities and challenges." [5]

In addition to that reviewed work describes systematic approach that helps to integrate NTCP analysis in the traditional project planning (combination object process methodology (OPM) and the second is the NTCP framework). Such approach is considered to be easy-to-use even for inexperienced project managers. The main steps of the proposed algorithm are described below:

1. Define project scope and the work breakdown structure of the project.
2. Based on the WBS, obtain sequenced activity list, resources associated with activities, activity durations (build OPM model).
3. Define NTCP values of activities.
4. Apply a bottom-up algorithm to assign NTCP attribute values.
5. Identify relative importance (centrality) of each activity for the success of the project.
6. Determine the criticality of each activity, depending on its centrality and its NTCP values.
7. Identify potential pitfalls in the project (for example, highly critical activity with high values in one or more NTCP dimensions).
8. Assess the NTCP values of the entire project based on step 6.
9. Based on the research update project charter, project scope management, and project management plan. (steps 1-7 can be repeated, if necessary) [5]

The outline of the described approach can be found on the picture below.

Figure 4. The proposed process for the project time management process. [5]



Adaptive Project Management

Another area of research was around flexible Project Management approaches. Traditional Project Management includes the following project phases - planning, execution, monitoring and control and evaluation, while Adaptive Project Management includes learning element in addition.

In the Adaptive Project Management framework "projects are managed based on learning from actual project performance and these learnings are obtained and analyzed using quantitative methods." [4] This approach is similar to the Agile Project Management, which is broadly used in the Software Development area. Even though this methodology was originally designed for Software Development products, over the time it's ideas - like flexible product development - have spread over the other industries as well. "Agile project management and other similar methods focus mostly on the organizational aspects of adaptation process. Two principles are the most important:

- Iterative decision-making or making choices based on learning from the outcomes of previous decisions.
- Strategic flexibility or avoidance of irreversible decisions." [3]

"Adaptive management processes originally developed by the ecologists were much broader. In addition to organizational principles, they include quantitative analysis methods, which will improve decisions by analyzing actual project performance, particularly:

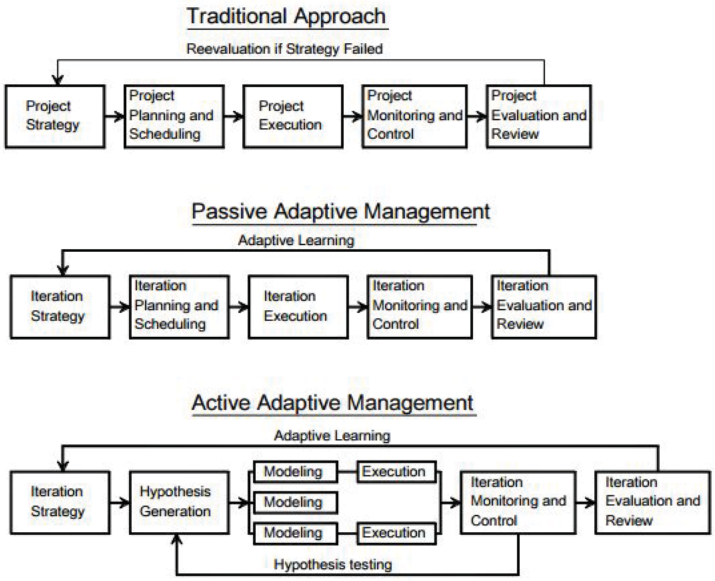
- Multi-model analysis and hypothesis testing
- Actual performance measurement
- Quantitative project cost and schedule risk analysis." [3]

"Adaptive management processes can be active and passive. The main objective of passive adaptive management is to incorporate the process of learning into existing management approaches. The learnings obtained from each iteration of the project can be used on the next iterations. In this manner, risk and uncertainties associated with each iteration can be significantly reduced. The goal of active adaptive management is to determine the best management strategy through experimentation. The process starts with hypothesis generation, which involves the selection of multiple alternatives for the strategy. The next step is to create models for each of the selected alternatives." [3]

Below are listed some practical recommendations on the Adaptive Project Management application, which are relevant to any type and size of the projects:

- Do not define a detailed project plan upfront, rather use an iterative project management approach.
- Always identify and assess multiple project alternatives or hypotheses.
- Apply quantitative cost and schedule risk analysis at each phase and iteration of the project.
- Rely on original assumptions and new learning when planning the next iterations or phase.
- Try to minimize risks by making sure that the option to change project direction is always available. [3]

Figure 5. Traditional project management process versus active and passive adaptive management processes. [3]



5. Explorative Project Management

Further will be presented the approach called Explorative Project Management focused on management of the innovative projects, that contain element of research and therefore don't have clearly defined scope at the beginning of the project and have a relatively high risk of failure.

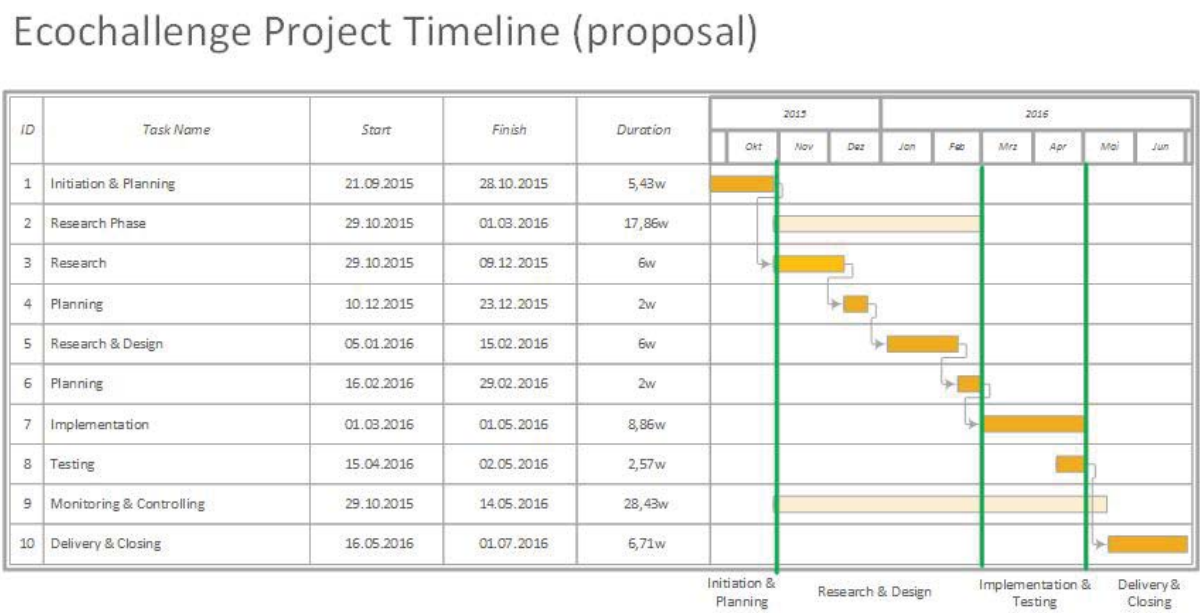
- "Diamond Framework". Deep understanding of the nature of the innovation, which is brought by the project as a whole and the contribution of each of the project parts to the overall project success is crucial to the successful management of innovative projects. This would contribute to the higher quality of the risk analysis, activity scheduling and choice of the adequate management approach. Therefore analysis based on the "Diamond Framework" during the planning phase of the project is one of the key activities.

  As an example, below is presented the analysis of the Innovative Project using "Diamond Framework". This analysis shows that while complexity and time pressure were not high in this project, the main risks were related with the high level of novelty and technological complexity of this project. Per work of Shenhar et. al. this project has high risk of delays, budget overruns and product failure and possible problems with further presentation resulting product in the market. Also this type of project requires longer design, build and test periods.

- Iterative Research & Design Phase. Since at the beginning of the innovative project in many cases the scope definition is ambiguous and requires additional detalization. This detalization in the overviewed example was occurring during Research & Development Phase of the project, which lead to the significant changes in the scope, schedule and budget. Below is proposed the iterative approach for the project planning based on the passive Adaptive Project Management concept. What is also important to mention, that not only project description should be updated based on the results of each iterations, but also the Project Management approach.

Figure 6.”Diamond Framework” analysis of Innovative Project. [own source]

Figure 7. Proposed project schedule for Innovative Project. [own source]



- Traditional Project Management Tools. even though the traditional approach to planning of the Innovative Project in the overviewed example was not recognized as efficient, the traditional Project Management tools were still of the great help.

In addition to that, the project success should be understood in a broader sense, when talking about innovative projects. Even though there are high risks of not meeting the schedule and budget baselines or not delivering the originally defined scope, the result of the project still might contribute greatly to the long-term development of the company and industry.

6. Results and Conclusion

This paper presents the approach to management of innovative projects - Explorative Project Management. The key traits of this approach is that it is applicable to any type of the project and allows not only to be flexible in planning based on the results received during the research phase of the project, but also learn how to manage the specific project, based on the inputs from the previous iteration(s). In addition to that the methodology that comes along with the “Diamond Framework”

gives deeper understanding on the nature of the project, possible risks and gives recommendations on the management style, that would fit the best this specific project and/or it's part.

The further research will performed in the areas the quantitative risk analysis and subsequent risk management, along with development of the hands-on approach for the iterative planning of the the small innovative projects.

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